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1. EXECUTIVE OVERVIEW

1.1 This annual operational business plan:

- Implements the ***mandatory*** Department of Defense (DoD) requirements of the Information Technology Management Reform Act (ITMRA) which specifically state, "Information support providers, in house and contractors, ***MUST*** maintain a program of ***CONTINUAL*** improvement keyed to user requirements, software best practices, and the **software capability maturity models**." [OSD C^3I 97].

- Serves as the Defense Logistics Agency (DLA) ***Business Case*** for Software Process Improvement as defined by the General Accounting Office (GAO); i.e., "a structured proposal for business improvement that functions as a decision package for organizational decision-makers. A business case includes an analysis of business process performance and associated needs or problems, proposed alternative solutions, assumptions, constraints, and a risk-adjusted cost-benefit analysis [GAO97].

- Depicts how the current and future DLA Software Process Improvement effort supports the **ITMRA**, the Government Performance Results Act (**GPRA**), the DoD Internal Management Control (**IMC**) Program, the DoD Information Technology Management (**ITM**) Strategic Plan, DoD Software Development and Documentation (**MIL-STD-498**), the DoD Acquisition Program (**DoD 5000**), the DLA Information Resource Management (**IRM**) goals, the **DLA-AQ** Information Resource Management (IRM) Strategic Plan, the **DLA-MM** Strategic Plan, DLA Chief Information Officer (**CIO)** policy directives, and the **DSDC** annual business plan.

- Lays out guidelines for continuing implementation of Software Process Improvement (SPI) at the DLA Systems Design Center (DSDC).

- Details the concept of operations for the SPI effort at DSDC.

- Fulfills the requirements of Organization Process Focus, a level 3 Key Process Area (KPA) of the Capability Maturity Model (CMM) for Software (hereafter referred to as the CMM).

1.2 The DSDC SPI effort is the corporate DSDC commitment for improving its capability to produce software. SPI is a focused, sustained effort for building a process infrastructure of effective systems and software engineering and management practices. The result will be improved quality of software, produced on time and within budget with reduced life cycle costs. This result, however, will be accomplished only by management's unified support of the structured set of goals and the collaboration and dedication of all DLA

Information Technology stakeholders, not just at DSDC, but at DLA as well. Implementing process improvements using the CMM is not just a DSDC issue. SPI is also a function of DSDC's customers who partner with DSDC to improve the way DLA, as one corporate entity, does business. Together we ensure that integration of and interfaces between the customer and DSDC not only support and facilitate the requirements of the CMM, but also the intent.

1.3 DSDC's SPI Vision

> ***"To build understanding, commitment and action among managers, practitioners and customers to sustain continuous improvement of software development processes."***

supports both the DLA and DSDC vision to be the "provider of choice."

1.4 This plan addresses the basic questions of: What is to be done? When? Where? How? By Whom? It contains workload projections and funding profiles for the next two fiscal years. This SPI plan contains the following attributes:

- It is a framework for orderly change by enhancing the ability to make changes compatible with the general direction and scope of the organization.
- It is consistent with the strong human need for order and predictability.
- It forces careful evaluation of priorities and consideration of new information (laws, strategic direction, etc.) that may not surface without special attention.
- The existence of such a written plan demonstrates deliberation and forethought on the part of DSDC management and places DLA and DSDC management in a position to exemplify their sponsorship, to aid in building cascading sponsorship, to develop champions within their hierarchy, and to justify budgetary support. It provides a tangible record of how goals are satisfied and resources are used.

1.5 The audience for this plan is corporate management and personnel (which includes DSDC and HQ DLA). The audience may also include our major customers; therefore, this plan is as much an externally-oriented document as it is internally-oriented.

1.6 This document contains information held as of **January 7, 1998**.

1.7 This plan will be maintained by the DSDC Software Process Improvement Office, reviewed annually, and updated as necessary.

1.8 This plan contains information that answers the following questions:

- What is SPI? What is the philosophy and how has it evolved?
- What is our motivation to improve?
- How does SPI support our business goals and objectives?
- What assumptions are we making?
- What are the organizational groups involved in SPI? How is each group organized? How do these groups interact?
- What are our SPI goals?
- What SPI actions are planned?
- How will DSDC change efforts be integrated?
- How will we measure success?
- How will we continue to improve?

2. OUTLINE

The following describes each section of the plan.

Philosophy: Defines the context and background for software process improvement within the DoD, introduces the methodology for the SPI effort at DSDC and defines the guiding principles for SPI.

Scope: Provides a definition of process improvement in a systems and software engineering organization.

Business Need for SPI: Contains the business need for improving DLA's software development processes.

History: Discusses the evolution of SPI at DSDC and provides a brief history of the assessment, improvement activities, and process assets that have been developed since the last SPI Operational Business Plan (FY96).

Organization for Process Improvement: Describes the resource infrastructure necessary to support and implement SPI changes at DSDC in terms of composition, structure, roles and responsibilities throughout the improvement effort, and interfaces and coordinating activities.

Assumptions: Reflects critical assumptions and describes how each of the assumptions affects SPI efforts within DLA.

Risks to SPI and Strategies to Overcome Risks: Identifies the risks, including the non-technological risks, to the improvement effort and describes the strategies to reduce those risks.

Management Approach: Outlines how DSDC will manage organizational changes that occur as a result of process improvement. Highlights our approach for SPI reporting, communication, and rewards and recognition.

Assessment Approach: Outlines the strategy for reusing process assets developed both internally and externally, and denotes the standards which govern the manner in which the SPI effort will be carried out.

Criteria for Success: Describes how goals will be measured and how DSDC will recognize success in achieving those goals. It also describes how improvement activities will be measured and evaluated at both the organizational and project levels.

Priorities and Schedules: Lays out the tenets to be used for developing schedules for improvement. Includes Gantt charts depicting which assessment

findings will be addressed and the sequencing and elapsed time for performing SPI work prioritized by the DSDC Executive Steering Group (ESG).

Resource Requirements: Includes funding strategies for SPI, together with a breakout of personnel, facilities, and budget needed to implement the priority actions of the ESG and to execute the SPI effort at DSDC. This section also contains requirements for tools and training necessary for software process improvement activities.

3. PHILOSOPHY

Defines the context and background for software process improvement within the DoD, introduces the methodology for the SPI effort at DSDC and defines the guiding principles for SPI.

3.1 DoD's Background in Software Process Improvement

Assessing the ability of a software development organization to develop quality software on time and within budget has been a large problem for the Department of Defense (DoD). In 1986, DoD tasked the Software Engineering Institute (SEI), established in 1984 at Carnegie Mellon University, to define a model that would portray organizational software process capability. The SEI is a federally-funded research and development center chartered to expedite systems and software engineering technology transfer leading to rapid improvement of the quality of operational software in the mission-critical [DoD] computer systems. The SEI, through research of the software engineering industry, developed and published the first version of the Capability Maturity Model (CMM) for Software in 1991. Development, and subsequent enhancements, of the CMM are the result of data collected by SEI from *thousands* of software development projects. While still sponsored by DoD (the SEI is funded by the authors of the DoD 5000 Acquisition regulations; specifically, the Office of the Secretary of Defense (OSD) Acquisition Program Integration (API)), the CMM is a public model for appraising software development capability that is widely accepted by the *International* software community. Proponents of the CMM include such renowned companies as **Citibank, Citicorp, Motorola, Xerox, Computer Sciences Corporation (CSC), Science Applications International Corporation (SAIC),** and **TRW** to name a few.

3.2 There Are No Silver Bullets!

Increasing software productivity and quality is the greatest challenge to our industry. To survive, we must learn to produce software better, faster, and cheaper. In a quest for a more efficient way, we [the software engineering industry] have failed to realize there are no easy solutions. We get caught up in the aura of our amazing software solutions to mind-boggling problems in other domains. We become enthralled with wonderful new fads and gadgets that promise to pull us out of our software production drudgeries. We subscribe to the naive belief that a single method or technology (such as computer-aided software engineering (CASE) tools, Total Quality Management (TQM), or up and coming design methodologies and life-cycles) will create the monumental gains in productivity and quality. Worse, we believe we can solve our problems if we just contract them to someone else. We think we can tame the software beast with *Silver Bullets* when there are none. So how do Silver Bullets cause program failures? The search for magic solutions diverts us from the more important

search for mundane ones. We neglect proven, reliable solutions and invest in the hope that a magic one will arrive. They make us focus all our attention on ONE method or technology promising vast improvements, rather than implementing proven ones in PARALLEL [GLASS92]. It takes more than just one tool or technology change for significant process improvement. Multi-faceted approaches, including tools, methods, techniques, and processes in parallel, are the *proven* way to making progress [JONES94].

3.3 The Operational Framework

When we talk of SPI at DSDC, we focus, in parallel, on all of the pieces that support implementation of significant improvements. Here we see how policies, processes and tools fit together into an *Operational Framework*, developed by the Software Engineering Institute (SEI). It starts with:

POLICIES which are laws or regulations. The DSDC SPI effort uses the components of the DoD 5000.1, Defense Acquisition, including DoD's concepts for using Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPTs) for developing systems, maturing our software development processes, continuous improvement, and tailoring.

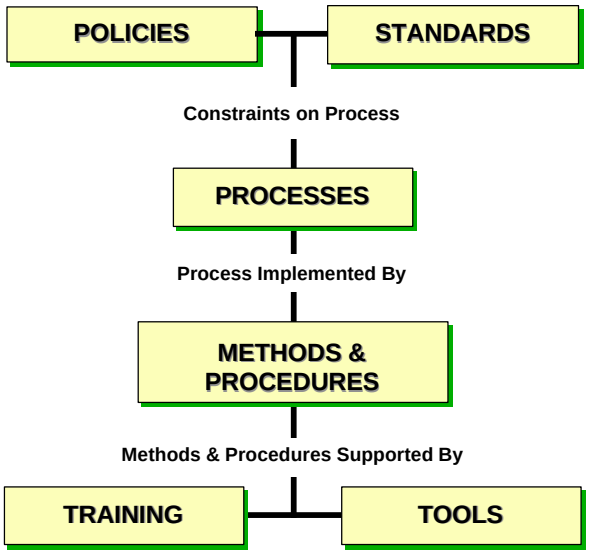


Figure 1. Operational Framework

STANDARDS define the acceptance criteria for a product. Policies tend to be more politically-oriented whereas Standards are more logically based. Until the industry equivalent is in place, DSDC uses the concepts behind MIL-STD-498, Software Development and Documentation, including the ideas of tailoring data item descriptions and life cycle model selection to fit the needs of each specific project. Policies and standards provide appropriate guidance or constraints for:

PROCESSES which describe "what" happens. Organizational standardization occurs at the process level. Without standardized processes, an organization cannot implement Activity Based Costing (ABC). Level 2 processes include project planning and management, requirements and configuration management, and software quality assurance for both ourselves and our subcontractors. Level 3 processes include standard process definition, management, and training across the whole organization, product (or software)

engineering, and better communication through peer reviews and intergroup coordination. Processes are highly repeatable and highly reusable. Processes are implemented by:

PROCEDURES which describe "how-to." Procedures are highly repeatable and can be highly reusable in a similar domain. Procedures are tightly coupled with tools and the environment in which they are used, e.g., mainframe, UNIX, PC, etc. For this reason, it is virtually impossible for a multifunctional CDA to totally standardize at the procedure level (i.e., use only one procedure). Procedures are supported by:

TOOLS which can be automated or non-automated. An automated tool is tightly linked to its procedures, i.e., UNIX tools use UNIX procedures, mainframe tools require mainframe procedures. Higher level organizations have identified and understand the policies and standards that constrain their processes which are implemented through procedures and tools. In other words, they start at the top of the operational framework. As a result, better tool decisions are made. All of the levels require:

TRAINING AND EDUCATION to provide real people with the skills and knowledge to understand and use the policies and standards, processes, procedures and tools.

4. SCOPE

Provides a definition of process improvement in a systems and software engineering organization.

4.1 What is Software Process Improvement?

4.1.1 DoD Says . . .

The concept of process improvement is not a panacea, a quick fix, a passing fancy, nor a trendy management buzzword. It is a framework from which an ideal state can be approached. It places your organization in a state of constant improvement to produce customer-defined quality products. Former Under Secretary of Defense for Acquisition, **Robert B. Costello**, defined process improvement as,

> *" . . . not a finite program with a beginning and an ending. It must be woven into the fabric of a management style. It must be built into the way we do our day to day business . . . [It] is not a vague concept, nor a program. It's a managed, disciplined process for improving quality, increasing productivity, and eliminating non-value-added activity. From a conceptual viewpoint . . . quality management makes the top managers squarely responsible for the quality of the organization"* [COSTELLO88].

4.1.2 DSDC Says . . .

The DLA Software Process Improvement (SPI) initiative is the Corporate Commitment for improving DLA's capability to produce software. SPI is a focused, sustained effort at building a process infrastructure of effective and efficient systems and software engineering and management practices. Improving DLA's software process results in better management of software costs and schedules, product functionality, and quality. DSDC believes that software systems should be fully system engineered. DSDC has the know-how to analyze business, functional, and performance requirements; to decompose systems into high level components; to design, develop and integrate software systems and to test our systems thoroughly. This is the essence of SPI at DSDC--moving software development from an "art" or "craft" to an engineering profession and discipline.

The Software Engineering Institute (SEI) believes that the quality of a product is a direct function of the process capability, the technology capability, and the people capability used to develop the product [BATE95]. An organization must not ignore any of the three "footers" in the foundation for building capability to provide quality products and services. The SEI believes any improvement effort must work these issues in parallel.

4.2 Three Necessary Components for Improvement

Organizations trying to improve their capability, effectiveness or efficiency often discover a number of interrelated components must be addressed. Three necessary components for improvement are: People, Process, and Technology [HEFLEY95]. Improving the systems and software development process results in better control and tracking of software costs and schedules. This concept is the reason why the software development industry is now turning its focus on systems and software engineering process improvements as the means for improving the quality of software products.

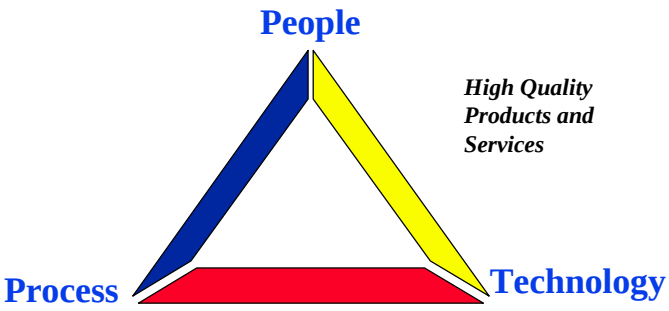


Figure 2. Necessary Components for Improvement

Systems engineering is the selective application of scientific and engineering efforts to:

- transform an operational need into a description of a system configuration which best satisfies the operational need according to the measures of effectiveness;
- integrate related technical parameters and ensure compatibility of all physical, functional, and technical program interfaces in a manner which optimizes the total system definition and design;
- integrate the efforts of all engineering disciplines and specialties into the total engineering effort [FM770-778].

Software engineering is the application of tools, methods, and disciplines to produce and maintain an automated solution to a real-world problem. It is the ability of the organization to perform successfully in terms of cost, schedule, product functionality, and quality. The capability has several dimensions, including (1) the expertise, experience, training, and motivation of the *people* performing and managing the work, (2) the *process* capability, and (3) the *technology* that is available and applied [BATE95].

4.2.1 Process

To understand SPI, one must first understand process. *Process* is defined as, "the means by which people, procedures, methods, equipment, and tools are integrated to produce a desired end result" [CURTIS93]. In the past, software development focused on building a product with very little emphasis on the

actual development process. This approach attempted to ensure quality by inspecting and removing defects. Since it is nearly impossible to test every software path, many errors went undetected. A better method is to build the quality into the process so the errors are prevented from getting into the software in the first place. This is the concept behind the Capability Maturity Model (CMM) and the SPI effort at DSDC.

4.2.1.1 The Capability Maturity Model for Software

The CMM defines the characteristics of an organization as it matures in its ability to engineer software. It provides a framework for improving software processes and achieving quality results by describing the stages through which software organizations progress as they define, implement, evolve and improve their software processes.

The CMM organizes the stages of software development capability into a model with five levels: Initial, Repeatable, Defined, Managed and Optimizing. At Level 1, processes are unfocused and ad hoc. Level 2 has a project focus. Requirements and software configuration management, project planning and management and software quality assurance can repeatedly be performed for both in-house and sub-contracted projects. At Level 2, processes exist for each project; however, these processes are not necessarily integrated or performed exactly the same on each project. That's a Level 3 effort where an organization moves from a project focus to a corporate focus. Processes become standard and consistent across the organization. Level 4 focuses on increasing quality through process metrics and Level 5 focuses on defect prevention and technology innovation.

Capability Maturity Model (CMM) Version 1.1

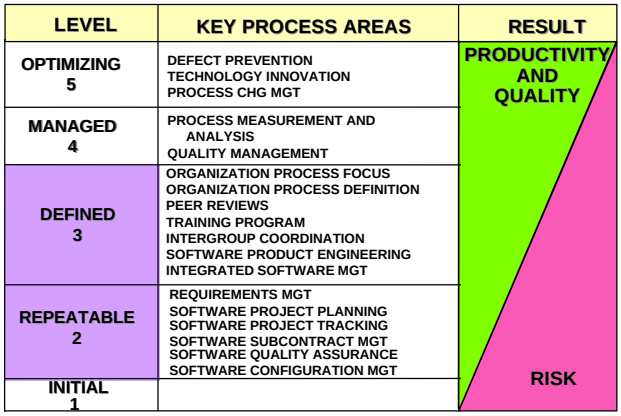


Figure 3. The Capability Maturity Model (CMM) For Software

The CMM is intended for use in conjunction with an assessment methodology and a management system. Assessments help an organization identify its specific maturity status, and the management system establishes a structure for implementing the priority improvement actions.

4.2.1.2 CMM or ISO?

The CMM and the ISO 9000 series of standards developed by the International Standards Organization share a common concern about quality and process management. The ISO 9000 series deals with quality systems that can be used for external quality assurance purposes. The specific standard in the ISO 9000 series of concern to software organizations is ISO 9001. Although there are specific issues that are not adequately addressed in the CMM, in general the provisions of ISO 9001 are encompassed by the CMM. The converse is less true. ISO 9001 describes the minimum criteria for an adequate quality management system rather than process improvement, although future revisions of ISO 9001 may address this concern. The differences are sufficient to make a rote mapping impractical, but the similarities provide a high degree of overlap.

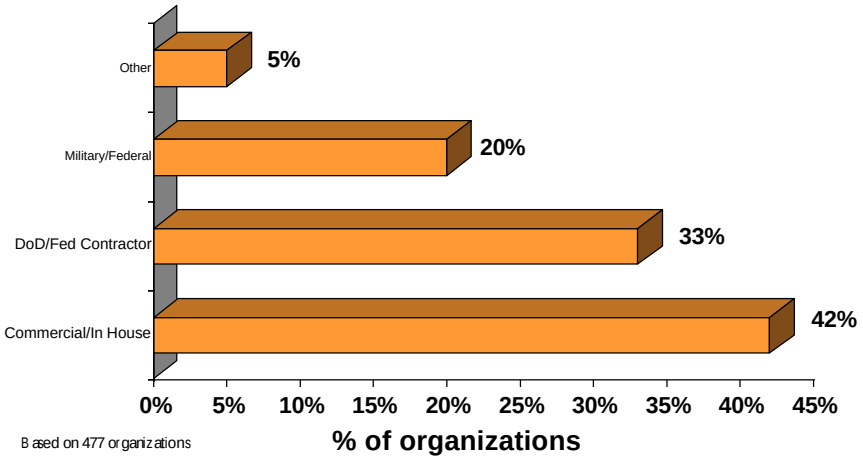


Figure 4. Organizations Using the CMM By Type

Should software process improvement be based on the CMM, with perhaps extensions for ISO 9001 specific concerns, or should the improvement effort focus on certification concerns? A market may require ISO 9001 certification, and Level 1 organizations should profit from addressing the concerns of ISO 9001. It is also true that addressing the concerns of the CMM would help organizations prepare for an ISO 9001 audit. Although either document could be used to structure a process improvement program, the more detailed guidance and greater breadth provided by the CMM suggests that it is the better choice. This may be especially true for DoD software development organizations where the focus is on CMM Level not ISO 9001 certification. In any case, building competitive advantage should be focused on improvement, not on achieving a score, whether the score is a maturity level or a certificate [PAULK93 and PAULK94]. At DSDC, our SPI efforts advocate addressing the larger context encompassed by the CMM.

4.2.1.3 Integrating the CMMs

There are many possible improvement paths and each organization must pick the one that best matches its needs; the Capability Maturity Model for Software best matches DSDC's needs and is the model that DSDC will use as the basis

for its improvement efforts. While it does not represent *all* of the challenges that face our Agency, there is nothing in the CMM that does not apply to DLA. To help us achieve our software CMM goals over the next two years, DSDC will be analyzing and integrating specific features of other CMMs that have proven to be helpful to software development organizations within a larger enterprise:

- The People CMM (P-CMM) (see paragraph 4.2.3)
- The Software Acquisition CMM (SA-CMM), which is applicable to an acquisition organization
- The Systems Engineering CMM (SE-CMM), which addresses the organization building systems (larger than the software development organization if systems include hardware and software), and
- The Integrated Product Development CMM (IPD-CMM), which addresses the product enterprise and includes marketing, manufacturing and business management, as well as the software developer.

4.2.2 Technology

The term ***"technology"*** involves many elements when applied to software. It can include methods, languages, tools, metrics, facilities, techniques, processes, hardware, other software and/or anything *nonhuman* used in the production or support of a software-intensive system.

While using new technologies, such as CASE, is a proven method for increasing productivity, DLA has been ineffective in *nearly* every attempt at acquisition and continuous management of new tools, whether they be CASE tools, Configuration Management Tools, Project Management Tools, etc. DLA is not alone. Most software organizations jump on many a hype bandwagon and select and acquire numerous tools without benefit of *detailed* knowledge of the *development process*. Once a financial commitment has been made, organizations find the tools do not mesh well with established processes. They do not anticipate the extra time and resources required to train *developers* to learn the new procedures required by the tool, or that they may have to adjust their processes and procedures to fit the tool. Attempts are also made to make the process fit the tools--which never works [QUANN93]. Many projects have failed because organizations do not base their tool selection on a needs-driven process and a pre-acquisition determination that they will, indeed, be beneficial to the people who have to *use* them.

Having a defined, mature software development process is a fundamental prerequisite for successful technology use. Having an ad hoc, poorly controlled process almost guarantees failure. Any technology use must be based on detailed knowledge of programmer activities and software to be built, market analysis of tool availability, cost/benefit analyses, and research into tool evaluations by *practitioners and experienced software technology analysts*. This

implies you must have a technology strategy implemented through a *structured, methodical, well-managed* Technology Plan [MOSEMANN96].

4.2.3 People

Given the significance of concentrating on process improvements to enhance product quality, it is important to recognize that software engineering process improvements mean change, and change requires a significant amount of energy. It is a major goal of this plan to provide direction for utilizing that energy to implement changes for the improvement of the systems and software engineering process and to integrate all software process improvement efforts within DSDC. Such corporate focus and direction is possible only through collective action of all SPI participants and a continued concentration on the human aspects of change.

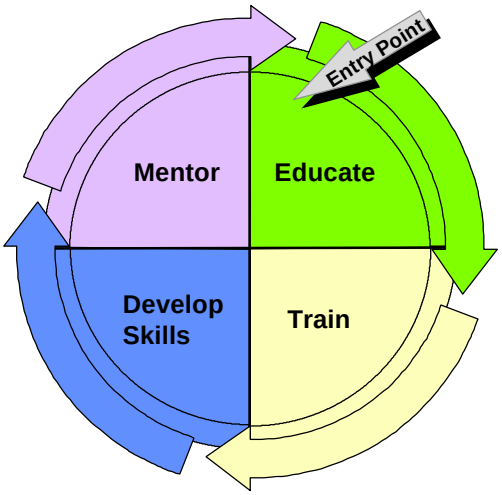


Figure 5. DSDC's Implementation Model

No matter what change is attempted, successful organizational change is dependent on changing people's behavior. It is much more than an education process. Too often, managers send people to training and expect them to immediately exhibit new skills and behaviors when they return. These education benefits (shared vocabulary, models, principles, and the tools needed to perform research) are only the first step toward defining desired behavior. After education, people must be trained to understand the details of specific jobs or tasks. The next level is skill development, wherein people have practiced and know how to perform an activity. And finally, workers need to be mentored to the point that they can perform these activities in the context of the mission.

This knowledge is the raw material of software development, and it is software engineers who transform this knowledge into software products. Although software processes and tools can help record and manage knowledge, they do not create and apply it. Therefore, improving technology and process alone is not enough in the most knowledge-intensive industry in history. As the size of software systems continues to grow an order of magnitude each decade, the industry must change from a mystique of artistically creative individuals to a team-based profession that emphasizes continuous learning.

To motivate continuous improvement of the workforce, DLA must perceive its software developers as assets rather than as expense items. Many organizations assert that their employees are their most important assets; others speak similarly about their suppliers. If employees and suppliers really are assets why then is this not recognized on the corporate balance sheet? Why is employee education and training charged to an expense account rather than an asset account? Assets are something desirable; why then do some organizations treat employees as if they are operating expenses--to be reduced as much as possible? Even considering people and suppliers as assets falls short of Deming's ideal as assets may be disposed of at will; Delavigne suggests that the proper relationship between employer and employee is that of partnership [DELAVIGNE94]. When members of the workforce are essentially interchangeable, organizations focus more on managing workforce costs than on increasing workforce performance. It is tragic when this old labor relations model is carried over into high technology, because it was based on jobs that were never as knowledge-intense as those in software development.

For this reason, DSDC will integrate its systems and software engineering process improvements with those contained in the People Capability Maturity Model (P-CMM). The P-CMM is a maturity framework, patterned after the structure of the CMM, that describes the key elements of managing and developing an organization's workforce. The P-CMM helps organizations characterize the maturity of their workforce practices, guide a program of continuous workforce development, set priorities for immediate actions, integrate workforce development with software process improvement, and establish a culture of systems and software engineering excellence.

Maturity Levels	Process Categories			
	Developing capabilities	**Building teams and culture**	**Motivating and managing performance**	**Shaping the workforce**
Optimizing (5)	Coaching Personal Competency Development	Continuous Workforce Innovation		
Managed (4)	Mentoring	Team Building	Organizational Performance Alignment Team-Based Practices	Organizational Competency Mgt
Defined (3)	Competency Development Knowledge and Skills Analysis	Participatory Culture	Competency-Based Practices Career Development	Workforce Planning
Repeatable (2)	Training Communication	Communication	Compensation Performance Management Work Environment	Staffing
Initial (1)				

Figure 6. The People Capability Maturity Model (P-CMM)

5. BUSINESS NEED FOR SPI

Contains the business need for improving DLA's software development processes.

5.1 First, A Testimonial

"Imagine what it would be like to work in an environment rich in well-coordinated and tested processes: everyone is trained and you could accurately estimate a job, finish it on time, within budget, and with exceptionally high quality. Nobody argues over who is at fault for a problem or who is responsible for a particular task. While you are dreaming, toss in some well-pleased managers and many proud employees. This is not a dream-I am describing the software organization of the Boeing Inertial Upper Stage (IUS) project. The IUS is a satellite boost rocket known for its high reliability and accuracy.

As a defense contractor who designs software used to launch satellites that may cost over a billion dollars, it would have been reasonable to adopt the CMM just to appease our customer, the U.S. Air Force. However, the most tremendous benefit of high-maturity processes has been the Air Force's satisfaction and confidence in our organization-not because of our CMM rating, but because of our high quality and predictable cost and schedule.

The accumulation of metrics and a procedure to estimate labor has also made it much easier to project the cost and schedules of new work. When I need to estimate new work, I start with a trip to our software library to check the procedure and to find metrics for similar work performed in the past. This facilitates realistic schedules, better planning, labor forecasting, and more efficient lab usage.

It required quite a bit of work to put the CMM in place, but the daily pay-backs have made my job more satisfying, with fewer problems to deal with, easier planning, better results, and on-time and on-budget design activities. It is no longer a subject of our dreams, and the effort was well worth it."

Kinsey M. Fowler.
Boeing Defense and Space Group
[FOWLER97]

5.2 Initiative To Improve

There are costs associated with maintaining the status quo. These involve test and defect correction costs, lost revenue from delayed product deliveries, and lost sales due to customer dissatisfaction. Coupled with rapid technological advances in the industry allowing for new solutions to customer problems, the costs for software development at lower Capability Maturity Model (CMM) levels will likely increase rather than hold steady. There are also often indirect costs from lost new product opportunities or a delay in anticipated cost savings. In a fee-for-service environment with continual downsizing, budget cuts, Base Realignment and Closure (BRAC), and the increased impetus to reduce costs and schedules and increase quality, DSDC can ill-afford to maintain the status quo.

5.3 Benefits

The primary benefit of an improved--that is, more disciplined--software process is improved visibility of the process. This visibility makes the process more manageable during software development and maintenance, thus reducing risk. Schedules and costs are more predictable and software is of higher quality at delivery and is easier to maintain. The cost of investment in process improvement work is amortized and ultimately more than repaid as illustrated in this figure [FOWLER90].

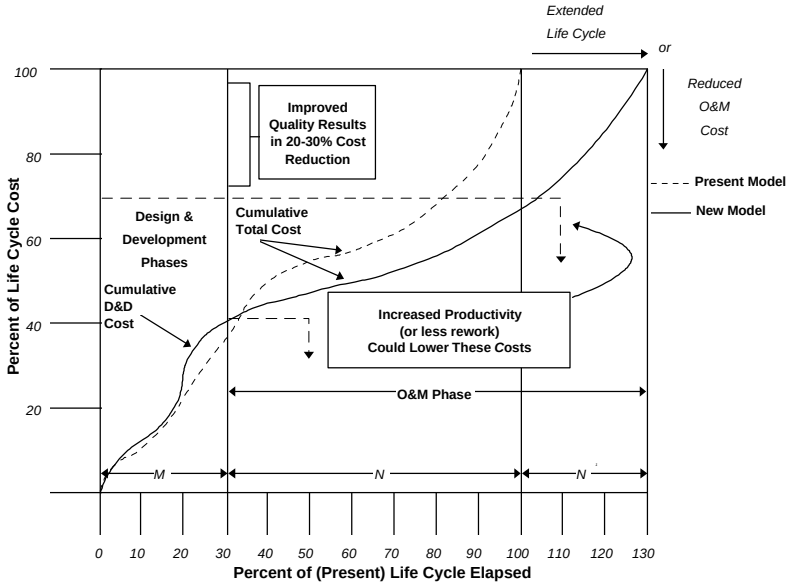


Figure 7. Benefits of a Mature Software Engineering Process Reprinted from [JACOBSEN89]

The preceding figure shows an academic example of the economic value of software process improvement. Below we have included a table which shows the actual results of moving up the SEI scale from a high level 1 to a low level 3 over the time period 1988 to 1992 for one system done at the Standard System Center (SSC), Gunter Annex, Maxwell AFB, AL. Putnam describes how the measurements were made and illustrates a number of other projects using real data from the SSC where substantial benefits were obtained [PUTNAM93].

Size - 162,000 SLOC		*			
Management Parameters	**Before SEI Lvl 1-1988**	**After (Actual) SEI Lvl 3-1992**	**Difference**	**% Difference**	**Benefit Ratio**
			Benefit		
Time, Mos.	24.5	14.3	-10.2	-41.6	1.71
Effort, PM	1494	263	-1231	-82.4	5.68
Uninflated Cost, $000	$5,716	$1,008	($4,708)	-82.4	5.67
Peak Staff, People	100	31	-69	-69.0	3.23
Mean Time To Defect (MTTD), Days	0.43	1.38	0.95	220.9	3.21

Table 1. Economic Comparison: CMM Level 1 to CMM Level 3

5.4 Return on Investment (ROI)

5.4.1 Industry Experience

5.4.1.1 Capers Jones Data from Use of Different Software Technologies

Since the entire field of quantifying return on investment (ROI) for software technologies is both new and uncertain, there is not yet any definitive data on what constitutes a "good" or "bad" investment. Capers Jones' preliminary data suggests that a five-level classification may be useful, with the darkest shaded areas showing the highest ROI:

Excellent ROI	=	>$15.00 returned for every $1.00 invested
Good ROI	=	>$10.00 returned for every $1.00 invested
Fair ROI	=	>$ 5.00 returned for every $1.00 invested
Marginal ROI	=	>$ 2.50 returned for every $1.00 invested
Poor ROI	=	<$ 2.50 returned for every $1.00 invested

The values shown on the following pages are based on both observation and modeling. They are quite preliminary and future data may change the results substantially. Indeed, the data which follows has a very high margin of error, and should not be used for any purpose other than preliminary discussions and informal analysis. Even so, it is encouraging that the software industry has reached a level where ROI studies are technically feasible. The ROI data is sorted in order of the maximum return after 48 months of *usage* and shows the approximate return each year for an initial investment of $1.00.

As software process improvement results in improved software engineering practices, many benefits are likely. These benefits have been mapped to specific technologies (or software engineering improvements) reprinted from [JONES94].

- **Reduced development costs -** There is less development and more reuse.

Technologies (Approximate return for each $1.00 invested)	12 Months	24 Months	36 Months	48 Months
Full software reusability	$1.00	$3.00	$15.00	$30.00
Reusable architectures	.00	.20	.75	1.50
Reusable estimates	.20	.30	2.00	3.00
Reusable plans	.15	.25	1.00	2.00
Reusable requirements	.10	.40	1.50	3.00
Reusable designs	.10	.40	2.50	5.00
Reusable source code	.15	.50	2.50	6.00
Reusable user documents	.05	.10	.75	1.50
Reusable human interfaces	.00	.15	.50	1.00
Reusable data	.20	.30	1.75	3.50
Reusable test cases	.05	.40	1.75	3.50

Table 2. ROI for Software Reusability Technologies

- **Increased quality in products and services**
- **Decreased reliance on testing to ensure quality** - Reviews become an integral part of the process--throughout the life cycle.
- **Reduced rework** - Problems are identified and eliminated early in the process rather than later.

Technologies (Approximate return for each $1.00 invested)	12 Months	24 Months	36 Months	48 Months
Baldridge Award (Winning)	$4.50	$7.00	$12.00	$20.00
Formal design inspections	3.50	6.00	10.00	15.00
Formal code inspections	2.50	6.00	12.00	15.00
Joint Application Design (JAD)	2.25	4.00	7.50	10.00
Process assessments	1.50	3.00	6.00	10.00
Baldridge Award (Applying)	1.10	2.00	6.00	9.00
Total Quality Management (TQM)	.85	1.50	4.50	8.50
Executive briefings (software)	1.75	2.50	5.00	7.50
Informal reviews	1.50	2.50	3.00	4.00

Table 3. ROI for Quality Technologies

- **Increased project efficiency**
- **Efficient project staff start-up time** - There is a documented process on which to train staff.
- **Efficient matrixed management of resources** - There is a higher likelihood that all projects will be conducted in a more uniform fashion making it easier for technical staff to move across projects.
- **Faster project start-up** - The project can build on and tailor a documented history of what it has done in the past.

Technologies (Approximate return for each $1.00 invested)	**12 Months**	**24 Months**	**36 Months**	**48 Months**
Improved management training	$1.15	$3.00	$5.50	$9.50
Improved staff training	.90	2.00	5.00	7.50
Staff specialization	.75	1.75	3.00	5.50
Standard development methods	1.25	2.00	3.00	5.00
Formal standards	1.00	1.15	1.75	3.00

Table 4. ROI for Methods/Standards/Training Technologies

- **Improved predictability of budgets, schedules and documentation** - Development activities are stabilized resulting in knowledge of what to measure, when to measure it, and how to use the information.

Technologies (Approximate return for each $1.00 invested)	**12 Months**	**24 Months**	**36 Months**	**48 Months**
Software quality measurements	$1.15	$3.50	$10.00	$17.50
Productivity measurements	1.50	4.50	6.00	10.00
Functional metrics	1.75	3.00	4.50	8.00
Staff morale surveys	1.75	2.50	4.00	6.00
Software science metrics	.75	.65	.55	.45
Lines of Code (LOC) metrics	.70	.50	.40	.30

Table 5. ROI for Metrics Technologies

- **Improved teamwork** - Communication among the process users, managers, process developers, and customers is more effective.

Technologies (Approximate return for each $1.00 invested)	**12 Months**	**24 Months**	**36 Months**	**48 Months**
Long range technology planning	$1.00	$5.00	$10.00	$15.00
User satisfaction surveys	3.00	5.00	8.00	11.00
On-line reference/research	1.50	3.00	5.00	7.50
Inter-company technical exchange	1.75	2.50	4.00	5.50
Improved hiring practices	.95	2.00	3.00	5.00
Improved staff compensation	.40	1.25	2.50	4.00

Table 6. ROI for People-Related Technologies

- **Improved tool usage** - An improved process also allows easier acquisition and adoption of new technology, because that technology can be acquired in direct support of defined processes. The process definition necessary for a disciplined software process is also a *prerequisite* to reasoned analysis about which software tools and methods best support the goals and the creation of products and systems within the organization.

Technologies (Approximate return for each $1.00 invested)	**12 Months**	**24 Months**	**36 Months**	**48 Months**
I-CASE (full integration)	$1.50	$2.50	$10.50	$25.00
Project management support (Sizing, Estimating, Planning, Budgeting, Tracking, Assessment)	.30	.40	2.00	3.50
Data modeling support	.05	.10	.50	1.00
Requirements support	.00	.05	.25	.70
Analysis support	.10	.15	.25	1.00
Design support	.25	.45	1.50	4.00
Development support	.25	.45	1.50	5.00
Documentation support	.00	.05	.30	1.00
Quality support	.25	.30	1.50	3.50
Maintenance support	.05	.10	.50	1.00
Rework support	.10	.20	.50	1.50
Usage analysis support	.00	.00	.10	.30
Repository support	.10	.15	.50	1.50
Communication support	.05	.10	.75	1.00
Cost and Quality Estimation tools	2.50	5.00	12.00	17.50
Reengineering tools	1.50	2.50	10.00	12.50
Project Management tools	1.50	4.00	8.00	12.50
Reverse Engineering tools	1.25	2.50	4.50	7.50
Code restructuring tools	1.75	3.50	5.00	6.50
I-CASE Tools (1993 level)	.75	1.25	3.50	6.50
Groupware/network tools	1.25	2.00	3.00	6.00
Complexity analysis tools	1.30	2.00	3.00	4.50
CASE Tools (partial)	.80	1.10	1.50	2.50
LOC-based estimation tools	1.50	1.00	.90	.80

Table 7. ROI for Automated Tool Technologies

5.4.1.2 Software Engineering Institute Data From Use of CMM

The following four figures represent data from a SEI study of 13 software development organizations:

Bull HN	Northrop
GTE Govt Systems	Schlumberger
Hewlett Packard	Siemens Stromberg-Carlson
Hughes Aircraft Co	Texas Instruments

Lockheed Sanders
Loral Federal Systems
Motorola
USAF Tinker AFB Air Logistics Center
USN Fleet Combat Direction Systems Support Activity

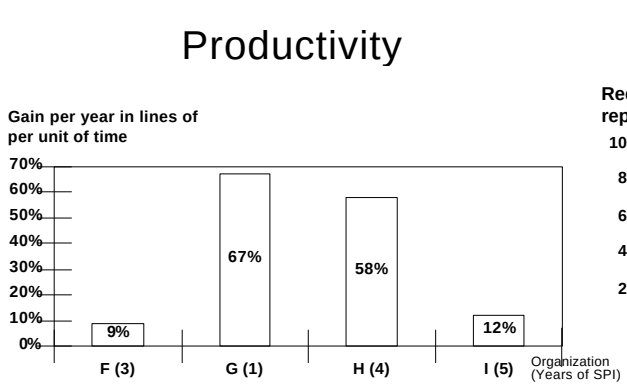


Figure 8. Productivity Returns from CMM Use

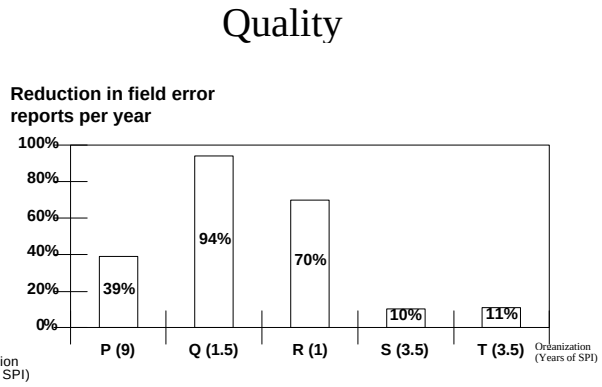


Figure 9. Quality Returns from CMM Use

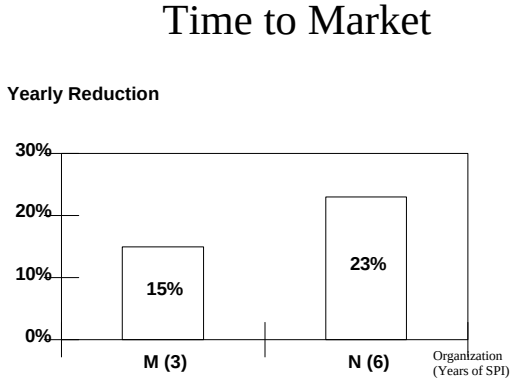


Figure 10. Time to Market Returns from CMM Use

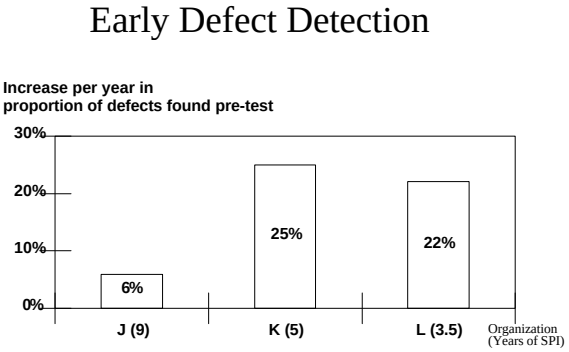


Figure 11. Early Defect Detection Returns from CMM Use

5.4.2 DLA Experience

In preparation for continued SPI planning, DSDC is defining metrics to calculate the Return on Investment (ROI) for managing projects at Levels 2 and 3 of the CMM. While industry data clearly shows staggering ROI numbers for CMM over long periods of time, the ROI metrics on the following pages are based on DSDC experience, to date.

Caution must be exercised since DSDC project metrics data is *extremely* limited from those projects that have made the climb to CMM Level 2. CMM Level 2 activities have not been implemented for a length of time sufficient to draw long-term conclusions. In addition, many of the DSDC projects that are being managed at CMM Level 2 had not completed at the time of this publication so project metrics data is “interim” only; it is not “final” data. Only by progressing in maturity does an organization start to capture the very metrics that are needed to build a ROI case. SEI finds that:

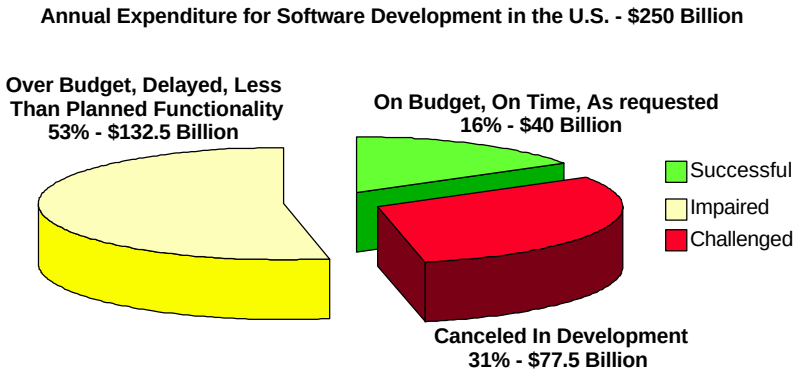
- Lower CMM Level organizations have too little data to develop ROI arguments
- Sound management and engineering practices should not have to be ROI issues
- Hard to quantify criteria
  - -competitive survival
  - -customer confidence and satisfaction
  - -product liability
- By the time data are available few need convincing
- Two groups who DO NOT ask for ROI arguments
  - -Level 2 and 3 organizations
  - -The Japanese

CMM Level 2 organizations are just starting to capture legitimate numbers and cannot speak factually about ROI. At CMM Level 4, organizations are performing statistical process control, have legitimate numbers and can defend all sorts of numbers, not just those for ROI. However, an investment has to be made in order to get to that point.

5.4.2.1 The Problem Is Not Confined To DSDC

In 1995, the Standish Group surveyed over 350 companies reporting on over 87,000 software projects (both military and private industry) and found:

- 31% of all software projects are canceled before completion
- 53% of projects will cost 189% of estimates



*** Conducted By the Standish Group International - Jan 1995**

Figure 12. The CHAOS* Study

- 16% will be delivered on time and on budget (in small companies)
- 9% will be delivered on time and on budget (in large companies)

In a further effort to understand the problem, the Standish Group asked respondents to identify the causes of these failures ("challenged"). Their results showed that *Lack of User Input*, *Incomplete [ambiguous] Requirements*, and *Changing Requirements and Specifications* were the Top 3 reasons why software projects are "challenged" [STANDISH94].

Although the CMM addresses many other process problems that plague the software industry, this paper concentrates on ROI from only three of the

practices at CMM Level 2 and 3: requirements elicitation, requirements management, and formal inspection of requirements documentation. Another 40-50% of the problems with software projects are addressed in other key practices of the CMM. DSDC is working hard to define, collect and quantify ROI from these other processes.

5.4.2.2 The High Cost Of Defects

Studies performed at GTE, TRW and IBM measured and assigned costs to errors occurring at various phases of the project life cycle. Later studies confirmed their findings that a defect costs 5 to 10 times less to detect and correct in the Requirements phase versus the Coding phase [DAVIS93].

In a study performed at Raytheon, Raymond Dion reported that approximately 40% of the total project budget was spent in rework costs [DION93].

Barry Boehm found that the cost of rework can approach 50% in the largest software projects. Because of the large numbers of requirements errors and their multiplying effects, finding and fixing errors consumes 70-85% of total project rework costs [BOEHM81]. Boehm provided the following relative cost ratio table to find and fix a defect by phase:

PHASE	COST RATIO
Requirements	1
Design	3-6
Coding	10
Development Testing	15-40
Acceptance Testing	30-70
Operation	40-1000

These increasing cost ratios reflect delays in error discovery, meaning that the cost of repair includes both the cost to correct the offending error and to correct subsequent investments in the error. These include software/system redesign, reworked code, documentation rewrite, and reworking or replacing software in the field.

The following spreadsheet shows three sample projects that implemented CMM Level 2 and 3 requirements techniques through education, training, skill development and mentoring (with money from the $1M FY97 investment from DLA-AQ).

PROJECT/ ARTIFACT	PROJECT/ ARTIFACT SZ	PHASE	TOTAL # DEFECTS	ACTUAL $ TO FIX	RANGE OF PROJECTED REWORK SAVINGS BY PHASE*		# MAJOR DEFECTS	RANGE OF PROJECTED REWORK SAVINGS FOR MAJOR DEFECTS*	
Project A	1091 fp	Requirements	337	$ 13,814.82			101		
Rqmts Doc	21820 loc	Design			$ 41,444.45	$ 82,888.89		$ 12,421.04	$ 24,842.07
	137 pg SSS	Coding			$ 138,148.15	$ 138,148.15		$ 41,403.45	$ 41,403.45
		Unit/Sys Test			$ 207,222.23	$ 552,592.60		$ 62,105.18	$ 165,613.81
		Accept Test			$ 414,444.45	$ 967,037.05		$ 124,210.35	$ 289,824.16
		Operation			$ 552,592.60	$ 13,814,815.00		$ 165,613.81	$ 4,140,345.15
Project B		Requirements	192	$ 29,982.86			10		
Rqmts Doc		Design			$ 89,948.57	$ 179,897.13		$ 4,684.82	$ 9,369.64
	321 pg SSS	Coding			$ 299,828.55	$ 299,828.55		$ 15,616.07	$ 15,616.07
		Unit/Sys Test			$ 449,742.83	$ 1,199,314.20		$ 23,424.11	$ 62,464.28
		Accept Test			$ 899,485.65	$ 2,098,799.85		$ 46,848.21	$ 109,312.49
		Operation			$ 1,199,314.20	$ 29,982,855.00		$ 62,464.28	$ 1,561,607.03
Project C		Requirements	27	$ 5,606.21			20		
Rqmts Doc		Design			$ 16,818.64	$ 33,637.28		$ 12,458.25	$ 24,916.50
	6 pg AWR	Coding			$ 56,062.13	$ 56,062.13		$ 41,527.50	$ 41,527.50
		Unit/Sys Test			$ 84,093.19	$ 224,248.50		$ 62,291.25	$ 166,110.00
		Accept Test			$ 168,186.38	$ 392,434.88		$ 124,582.50	$ 290,692.50
		Operation			$ 224,248.50	$ 5,606,212.50		$ 166,110.00	$ 4,152,750.00
*Based on formulas reported in Barry W. Boehm's book, *Software Engineering Economics* (Englewood Cliffs, N.J.: Prentice Hall, 1981).									

Table 8. DSDC ROI for Three Sampled Projects

Using Barry Boehm's cost ratio table, the CMM Level 2 and 3 requirements techniques employed by these 3 project teams *prevented* the introduction of 556 requirements errors. Had these errors gone undetected until time of acceptance testing (the time when we used to get all of the users/customers/developers together), these errors could have cost DLA between roughly $1.5 and $3.5 million. In this case, the ROI would be between 50% and 250% using only CMM requirements techniques on only these 3 projects! In the worst case scenario, if the errors on these 3 projects had gone uncorrected until after software deployment, the costs to DLA could have been as high as $49 million!

Even a conservative savings estimate, considering only the major defects, shows ROI. Of the 556 errors, 131 were considered *major* defects, meaning defects significant enough to cause product failure or rejection of the system. In looking at only major errors, CMM Level 2 and 3 requirements techniques on only these 3 projects prevented rework costs of between roughly $.3 million and $.7 million. In this scenario, DLA would only need to use the techniques (enabled by education, training, skill development and mentoring), on an additional 1-4 projects to achieve a ROI.

In either case, these figures *do not* take into account the positive impact which occurs when these techniques are transferred to other projects. More importantly, these figures *do not* take into account the cost of possible delays in fielding the software which, in turn, impact projected productivity and savings by the business areas within DLA.

In the following chart, you can see that we took one of the projects and decomposed the metrics further. This chart reflects a software-intensive system that was contracted to DSDC. In the first increment, 550 total defects were identified. Fifty percent of those defects were discovered during system testing (unit/integration testing in MIL-STD-498 terminology) and 50% were discovered by the customer in Functional and Environmental Testing (or during Computer Software Configuration Item (CSCI) Qualification and CSCI/Hardware Configuration Item (HWCI) Qualification) in MIL-STD-498 terminology). The system was ultimately rejected during Environmental Test and was not fielded.

In Increment 2, virtually the same project team was assembled to automate the customer's requirements. During this increment the Integrated Product Team (IPT), guided by the DSDC SEPG, began to implement CMM Level 2 practices and procedures on the project. During the Requirements Phase of this increment, the team discovered and fixed 44% of the total defects identified. This was done through CMM Level 2 requirements workshops and a CMM Level 3 formal inspection. Another 22% of the total defects noted in this increment were discovered and fixed during System (Unit/Integration) Testing.

	Incr #	Rqmts Peer Reviews/ Inspections	System Test (Unit/ Integration)	Functional Test (CSCI Qualification)	Environmental Test (CSCI/ HWCI Integration)	Total Defects Identified
# Defects	1	0	277	218	55	550
	2	192	97	129	21	439
Cum # Defects	1	0	277	495	550	550
	2	192	289	418	439	439
% of Total Defects	1	0%	50%	40%	10%	100%
	2	44%	22%	29%	5%	100%
Cum % of Defects	1	0%	50%	90%	100%	100%
	2	44%	66%	95%	100%	100%

Table 9. DSDC Project Economic Comparison: CMM Level 1 to CMM Level 2

In a study quoted by Tom DeMarco, 56 percent of all bugs were found to be traceable back to errors made during the Requirements phase [TAVOLATO84]. Eight years later, in a study of a U.S. Air Force project, requirements errors constituted 41 percent of all errors discovered [SHELDON92].

Using the data from these two industry studies, we can infer that the IPT captured most if not all (44%) of the requirements defects in the Increment 2

Requirements phase prior to those defects being introduced into subsequent (and more costly) phases of the project. As seen in Table 8 on the preceding page, had these defects gone unnoticed until Functional Test (CSCI Qualification), the project could have expended between $900K and $2M to find and fix the requirements defects (rework costs). **This rate of return for only one project is significant enough to fund the entire SPI effort at DSDC/DLA for all of FY98** (see the *Resource Requirements* section of this plan).

The productivity and quality results from our initial efforts are very encouraging. As we mature our metrics identification and collection process and establish an historical metrics database, we anticipate that, like other organizations using the CMM for improvement, we will validate the accuracy of our initial metrics analysis. It is one of our major goals to formalize and standardize the metrics collection and analysis process in the FY98-99 time frame.

5.5 Relationships To Goals And Objectives

5.5.1 Federal Laws, Policies and Standards

5.5.1.1 Information Technology Management Reform Act

The Information Technology Management Reform Act (ITMRA) of 1996 requires, among other things, that agencies set goals, measure performance, and report on progress in improving the efficiency and effectiveness of operations through the use of information technology. DoD will implement the ITMRA through the DoD Information Technology Management Strategic Plan. DSDC has successfully implemented its role in the ITMRA through the DSDC SPI efforts to date.

5.5.1.2 Government Performance Results Act

As its name implies, the Government Performance Results Act (GPRA) is designed to systematically provide Government decision-makers and the public with reliable information on what actual results federal programs and activities are achieving--i.e., what is working, what is wasted, what needs to be improved, and what needs to be rethought. And, most fundamentally, under the GPRA, every major federal agency must now ask itself some basic questions: What is our mission? What are our goals and how will we achieve them? How can we measure our performance? How will we use that information to make improvements? DSDC has asked itself those questions and our SPI efforts, as defined in this plan answers them.

5.5.1.3 General Accounting Office

The General Accounting Office (GAO) is the investigative arm of Congress. Charged with examining matters relating to the receipt and disbursement of public funds, GAO performs audits and evaluations of Government programs and activities.

5.5.1.3.1 Software Capability Evaluations Against the CMM

The GAO uses the CMM to evaluate the software development capability of government agencies via Software Capability Evaluations (SCEs) [GAO96].

5.5.1.3.2 Evaluating Federal Agencies' IT Investment Decision-making

The GAO uses their February 1997 guide, entitled, "Assessing Risks and Returns: A Guide for Evaluating Federal Agencies' IT Investment Decision-making" [GAO97] to evaluate how well federal agencies are implementing the ITMRA and the GPRA. In that guide, GAO uses this "*IT Investment Evaluation Approach with Key Elements*." Should GAO evaluate DLA against this guide, they would find that the SPI effort at DSDC directly supports all of the *Process, Data* and *Decisions* areas of outlined in the *Control* and *Evaluate* columns.

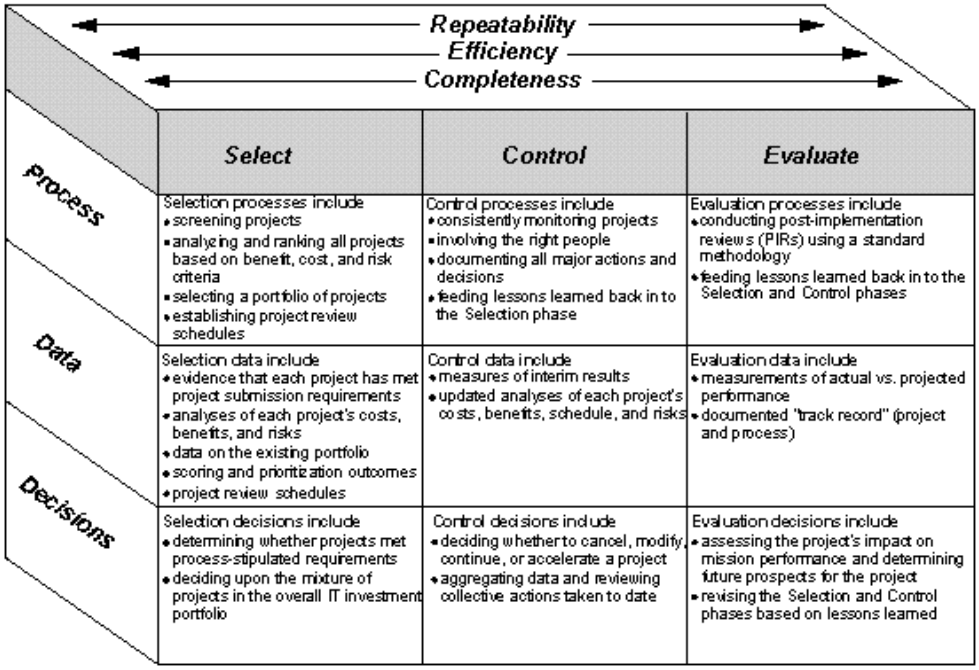


Figure 13. The IT Investment Evaluation Approach With Key Elements

5.5.2 DoD Policies, Standards, Regulations and Goals

5.5.2.1 DoD 5000, Acquisition Program

DoD 5000.1, Defense Acquisition, provides policy for *Acquiring Quality Products*. This policy, applicable to all DoD acquisitions, specifically calls out *Software-*

Intensive Systems and recognizes that “Software is a key element in DoD systems. It is critical that software developers have a successful past performance record, experience in the software domain or product line, *a mature software development process*, and evidence of use and adequate training in software methodologies, tools, and environments.” [DoD 5000.1]. The DSDC SPI effort fully and completely supports this policy.

5.5.2.2 DoD Sponsorship/Funding of the Software Engineering Institute

Effective in June 1997, sponsorship and federal funding of the Software Engineering Institute (SEI), authors of the CMM, is provided by the Office of the Secretary of Defense (OSD) Acquisition Program Integration (API). API is the author of the DoD 5000 directives. This coincides with an earlier decision by DoD to identify the CMM as a “DoD Best Practice.” It is the intent of the SPI effort at DSDC to reap the benefits of that DoD-funded research.

5.5.2.3 OSD C^{3}I ITM Strategic Plan

In March 1997, the Office of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) OSD C^{3}I published the DoD Information Technology Management (ITM) Strategic Plan, Version 1.0 which "provides an overarching vision and specific strategies to guide DoD in compliance with the ITMRA" [OSD C^{3}I 1997]. The plan specifies that DoD Components (such as DLA) "will inherit the DoD goals and strategies and identify supporting initiatives."

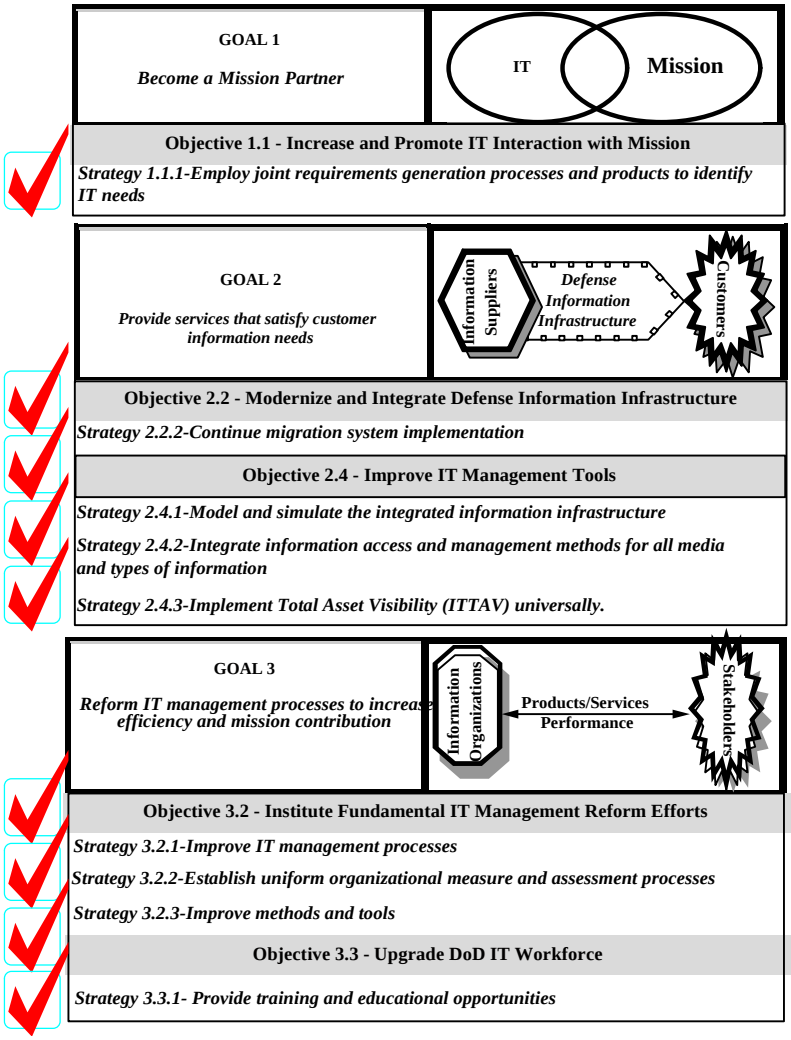


Figure 14. A Mapping of SPI to the DoD ITM Strategic Plan

The SPI effort at DSDC is "a supporting initiative" of the DoD ITM Plan. In that plan, DoD lays out four goals with supporting objectives and strategies. Our SPI Program fully and completely supports at least six of the ten strategies for these goals that DLA and the DLA CIO will be rated against. For example, under *Goal #2--Provide Services that Satisfy Customer Information Needs, Objective 2.2--Modernize and Integrate Defense Information Infrastructure, Strategy 2.2.2--Continue migration system implementation*, the plan specifically states:

> ***"Information support providers, in house and contractors, must maintain a program of continual improvement keyed to user requirements, software best practices, and the software capability maturity models."***

5.5.2.4 DoD Inspector General

During the last Inspector General (IG) visit to DSDC in the February 1997 time frame, the IG accepted the formal CMM assessment findings in lieu of conducting a separate IG investigation of DSDC. The assessment covered all areas that would be reviewed by the IG during an investigation of a Central Design Activity (CDA).

5.5.2.5 MIL-STD-498

MIL-STD-498 is the DoD standard for Software Development and Documentation [MIL-STD-498]. It replaced DoD-STD 2167A, Defense System Software Development (Feb 88) and DoD-STD-7935A, DoD Automated Information System Documentation Standards (Oct 88). Developed with input from both government and industry, MIL-STD-498 will soon be a U.S. standard (US 12207) and will be subsequently included in international standard J-STD-16. The 19 activities in MIL-STD-498 map to those contained in CMM Levels 2 and 3 making an extremely good fit with the DSDC SPI effort.

5.5.2.6 Defense Business Operations Fund (DBOF) / Defense Working Capital Fund (DWCF)

Each year as a requirement of the "DBOF Reports to Congress on Milestones I and II Implementation" (during the Presidential Budget submission), DLA must complete Exhibit 12, "Performance and Quality Measures." There are four performance and quality measure goals for a Central Design Activity (CDA). One of these four goals states, "Quality--CMM Level--This measures DSDC's progression up the Capability Maturity Model (CMM) developed by the Software Engineering Institute (SEI)--Goal is 100% Fully Satisfied at CMM Level 3 [DBOF93]. Our SPI budget submission reflects the funding necessary to achieve this goal.

5.5.3 DLA Policies, Standards, Regulations and Goals

5.5.3.1 DLA Internal Management Control Program

DLA Regulation 5010.4 implements DoD Directive 5010.38. The purpose of the Internal Management Control (IMC) Program is to comply with federal laws and Office of Management and Budget guidelines. As stated in these policies, “internal management controls should not be viewed as separate, specialized systems within the Agency . . . they are integral parts of managers’ systems used to perform the missions . . . and to account for its resources . . . IMCs are essential to assure that the mission is accomplished while maintaining full accountability over the processes, resources, and operations . . . IMCs make it easier to meet management objectives by serving as checks and balances

against unwanted actions or the lack of required actions" [DLAR 5010.4]. The DSDC SPI program completely supports IMC principles and policy.

5.5.3.2 DLA IRM Strategic Plan

The table on the following page depicts a mapping of DLA Information Resource Management (IRM) goals and objectives supported by DSDC's SPI efforts [IRM97].

DLA Strategic Goal	Business Objectives	Met by DSDC SPI?
Put Customers First	• Reduce logistics response time • Improve response on priority requirements • Increase product quality • Improve timeliness of responses for information or services • Measure customer satisfaction and broaden the business base by expanding market research capacity. • Improve customer complaint process. • Assist in definition of customers' information needs and opportunities. • Measure ourselves in terms of our contribution to our customers needs.	Potential X X X Partially Potential X Desired
Improve the Process of Delivering Logistics Support	• Provide users with timely and accurate information on the location, movement, status, and availability of DLA managed items. • Improve information transfer and shared access. • Expand the use of EC/EDI Emerging Technologies. • Enhance processes used to provide quality products and services to our customers. • Maximize use of commercial business practices. • Deliver technologically superior products. • Increase interoperability, accuracy, and sharing of business data.	N/A Potential Potential X X X X
Empower employees to get results	• Facilitate teaming and conferencing to bring human resources to bear on operational issues. • Expand opportunities for employee development. • Keep employees informed. • Create a positive environment with the partnering union. • Create a learning organization for enhancing employee skills and empowering employees to excel.	X X X X X
Meet Customer Readiness and Weapon Systems Acquisition Requirements at Reduced Cost	• Enhance weapon system support. • Reduce infrastructure by consolidating and using commercial services. • Buy response vice inventory. • Obtain, retain, and maintain sales base. • Reduce unit cost - know cost of doing business. • Increase use of commercial items, specifications, research and development. • Promote a performance based management environment. • Translate customer and support services workload projections into resource requirements for the mission.	N/A X N/A N/A X X X X

Table 10. A Mapping of SPI to DLA IRM Plan

5.5.3.3 DLA CIO Policy Letter

DLA-CIO policy Letter 96-12, Software Process Improvement, August 30, 1996, states "The SPI program will use the CMM as a measure of software process

maturity . . . As a measure of progress, DLA is to achieve a maturity Level 3 (defined process) by 1999." Our SPI plans support this policy.

5.5.3.4 DLA-AQ IRM Plan

Our SPI efforts support DCMC's IRM plans which state, in part, "DCMC's progress in providing a disciplined approach to program management is not restricted to internal efforts but is prevalent in the Command's interaction with automation service providers. DCMC is in the process of scrutinizing automation services providers to ensure the support they provide is of the highest standards. DCMC currently requires that software developers and providers attain a CMM Level 2 rating. In conjunction with DCMC's requirement that software providers attain CMM Level 2, DCMC is conducting CMM training for Program Officers (POs) and functional personnel. This training will familiarize DCMC personnel with the software engineering and management methodologies and practices incorporated by the software process improvement concept. The training ensures that customer and software provider expectations and outcomes are understood and agreed upon and met. The training will provide DCMC project personnel the tools to more effectively work with software providers and monitor the software development process. DLA System Design Center (DSDC) provides design and development support for corporate and functional application systems. DSDC continues working on a process improvement effort to improve its capability to produce software and is currently a certified Level 2 Software Developer" [DLA-AQ97].

5.5.3.5 DLA-MM Strategic Plan

All of the Stakeholders Goals referred to in DLA-MM's Strategic Plan [DLA-MM97] apply to DSDC as well, and are the very essence of the SPI effort at DSDC. In the subparagraphs below, we have reiterated DLA-MM's strategic goals from the DSDC SPI perspective, specifically:

- *Customer Goal - Dramatically improve response time, reliability, and communications*. Our DLA customers (-MM, -AQ, -CA) want--and deserve--on-time and reliable support, meaning confidence that the system or service we provide will consistently arrive on time and perform as intended. And they want an easy interface to obtain this support. Institutionalizing CMM Level 2 and 3 at DSDC is the mechanism for achieving this goal for our customers.

- *Customer Goal - Greatly reduce the total cost to our customers*. Our customers want our services to be affordable--truly best value. Institutionalizing CMM Level 2 and 3 at DSDC is the mechanism for achieving this goal for our customers.

- *Workforce Goal - Invest in our people to enable them to deliver and sustain world class logistics performance levels.* Like the DLA-MM workforce, our

associates are our true competitive advantage. We, too, are in a business of delivering on our ideas, and we can only do so through our people. Technology helps, but it's our people who fashion the ideas and turn those ideas into reality. By capitalizing on the diversity in our workforce and providing our workforce the tools, recognition and the development to do the job our other stakeholders expect of us, we can deliver on those expectations. This ideal is captured in all CMM levels under "Ability to Perform" and in CMM Level 3 under the Training Program Key Process Area (KPA).

- *Supplier Goal - Significantly enhance the ease with which we interface and partner with our suppliers.* Suppliers want us to be a reliable trading partner. They want stable, long-term relationships, certainty of prompt payment for products and services delivered, flexibility in how they meet our performance requirements, and consistency in how they are treated. We want this from our suppliers, as well. Additionally, as suppliers, we would like this to be the case with our customers. CMM Level 2, Subcontractor Management helps us to achieve this goal from our suppliers. Implementation of CMM Level 3 at DLA and DSDC helps us to achieve this goal as a supplier.

- *Shareholder Goal - Reduce the infrastructure needed to accomplish our mission.* Our shareholders provide us many of our policies and authority to operate: They include the Office of the Secretary of Defense, the Congress and ultimately the taxpayer. They want a government that "works better and costs less"--for us this generally means lower cost and less infrastructure. This entire plan addresses SPI efforts that are aimed at implementing the very laws and policies of these governing bodies. SPI ensures the taxpayer gets a government that works better and costs less.

5.5.3.6 Activity Based Costing (ABC)

DSDC's SPI efforts to achieve CMM Level 3 by defining and implementing an "organizational standard software development process" directly support moving towards Activity Based Costing (ABC). A basic tenet of the ABC paradigm is that an organization must first define its high level processes and the activities that support those processes. Organizational process definition is one of the key elements for achieving CMM Level 3.

5.5.4 DSDC Policies, Standards, Regulations and Goals

Our SPI efforts are included in every DSDC policy and plan we have prepared and submitted.

6. HISTORY

Discusses the evolution of SPI at DSDC and provides a brief history of the assessment, improvement activities, and process assets that have been developed since the last SPI Operational Business Plan (FY96) to date.

In the past, software development focused on building a product with little emphasis on the actual development process. This approach attempted to ensure quality through inspection and removal of defects at test time. DLA Systems Design Center (DSDC) realized that a better method was to build the quality into the process so errors are prevented from getting into the software in the first place. Recognizing that many software problems are related to management issues, the goal was to reinvent the processes being used to manage software development. To help achieve that goal, the DSDC Software Engineering Process Group, or SEPG, was established. Their formation coincided with the establishment of DSDC as DLA's one Central Design Activity (CDA) from five separate CDAs across DLA.

In just 15 short months, DSDC coordinated all of the efforts necessary to re-engineer all of the processes necessary for managing software development projects. These included processes for requirements management, project planning, project tracking, contractor management, configuration management, and software quality assurance.

The SEPG began their task by selecting a foundation for SPI activities. After benchmarking against industry, the SEPG selected the Capability Maturity Model (CMM) for Software developed by the Software Engineering Institute (SEI).

After selecting the CMM, the DSDC SEPG documented and created an SPI Operational Business Plan that included guidance and agreements negotiated with HQ DLA and DSDC senior management. This plan defined the philosophy for implementing SPI at DLA (the CMM) and established the scope of DSDC's business that would be addressed by the SPI effort. In the plan, the SEPG also documented a business case for SPI using the CMM, industry data, and the history of DSDC and past improvement efforts. It defined the groups that would be primarily involved as well as the assumptions, priorities, and resources for the SPI effort. The plan also identified the risks or barriers to implementing the many changes that would be necessary as well as strategies to overcome those barriers. The SEPG-developed plan documents the management and technical approaches that are used as well as metrics and success criteria for SPI. Finally, the SEPG laid out a schedule with six-month increments for moving DSDC from Level 1 to Level 2 to Level 3 of the CMM. In Increment 1, DSDC would define or document all of the requirements of CMM Level 2. In Increment 2, DSDC would work to improve and begin implementation of those processes across DSDC. In Increment 3, DSDC would undergo an external, formal, CMM

Level 2 assessment of one product line to validate that we were on the right track. After Increment 3, DSDC would also begin defining and documenting the requirements of CMM Level 3, would work to improve the CMM Level 2 and 3 processes, and begin implementation of CMM Level 3 across DSDC. Finally, DSDC would continue implementation and begin preparation for an external, formal, CMM Level 3 assessment of all DSDC products and product lines. All SPI goals, objectives and milestones identified in that plan were met.

Noting that, like 70% of the software engineering industry, DLA's software processes were at Level 1 of the CMM, the DSDC SEPG began defining and documenting all 827 of the CMM Level 2 process requirements. To do this, the DSDC SEPG coordinated a series of "best practice" workshops where more than 50 subject matter experts from across DSDC reviewed and analyzed more than 200 DSDC documents to determine which CMM requirements were defined or documented somewhere within the five organizations that had come together to form DSDC. After analysis, the data showed only about 38% of the Level 2 requirements had been defined or documented and that those process definitions were located across more than 100 separate documents.

During its planning activities, the SEPG took note of industry metrics which show that it takes between 18 and 36 months to move between Levels on the CMM. The SEPG planned to reduce the climb from Level 2 to 3 by incorporating a strategy for implementing Level 2 in a Level 3 way. While CMM Level 2 allows each project to operate under its own procedures, the DSDC SEPG recognized that this would not be feasible at DSDC where more than 100 projects are underway at any given time and that these projects span across 1200 associates in 7 geographic locations. Therefore, the SEPG spent the 60 days following the "best practice" workshops, consolidating the Level 2 process definitions, and working with DSDC subject matter experts to fill the process definition gaps in order to satisfy more than 92% of the CMM Level 2 definition or documentation requirements into a single DSDC process guide used by all DSDC projects (these metrics are available for viewing together with all DSDC metrics through the DSDC web site). On November 1, 1995, the SEPG published the first DSDC Process Guide for Implementing CMM Level 2. This guide forms the basis for DLA's standard software development process (a CMM Level 3 requirement). This process guide is available for viewing through the DSDC web site.

The SEPG also established management controls to ensure continuous improvements to the DLA standard software development process by establishing a periodic revision cycle for the process guide in order to incorporate recommendations for improvements by DSDC and/or DLA associates. Both World Wide Web (www.dsdc.dla.mil) and hard-copy versions of the guide are published quarterly by the DSDC SEPG.

Having defined the processes, the next step was implementation. The SEPG coordinated the use of a CMM self-assessment tool. This software is used by DSDC project managers to gauge their progress toward implementing the requirements of CMM Level 2 and 3 (using the process guide). The SEPG also initiated a pilot, whereby a small group of software projects were provided with training and mentors (called process consultants). The baseline metrics from all self-assessments proved that software project teams that are provided with training and one-on-one assistance can assimilate and implement change (the activities required by CMM Level 2) much faster than software projects that did not have that support (these metrics are available for viewing together with all DSDC metrics through the DSDC web site).

Using the data collected from the pilot projects, the SEPG utilized a four-faceted approach for implementing CMM Level 2 across one of DSDC's major product lines. The approach includes: Education, Training, Skill Development and Mentoring.

Educate First, provide education. The DSDC SEPG developed a 32-hour CMM Overview course which provides associates with conceptual modules on topics such as the CMM and the industry methods for CMM assessments and evaluations as well as overviews of the reinvented DSDC software management processes. During the course, students were also given up-to-date information on DSDC's efforts toward achieving the goals in the SPI Operational Business Plan. The SEPG trained more than 200 students from DSDC in addition to about 200 HQ DLA, customer and end-user representatives from the DLA-AQ/ DCMC and DLA-CAN communities.

Train In the second facet of implementation, the DSDC SEPG facilitated "Training" in the form of contractor-led "implementation" workshops. In the first of two "implementation" workshops, Integrated Product Teams (DSDC/Customer/User) learned how to recognize and write good, unambiguous, testable, system requirements statements as documented in DSDC's new requirements definition processes and procedures. In the second "implementation" workshop, the IPTs learned DSDC's reinvented processes and procedures for conducting formal inspections. These "workshops" were then integrated into the standard software development process so that the requirements and formal inspection processes are now led by DSDC associates rather than contractors (true technology transfer).

Develop Skills The third facet of the four-faceted approach is "Skill Development." The IPTs used the knowledge they gained in the two "implementation" workshops to develop their skills using their respective software projects' requirements documentation.

Mentor Finally, in the fourth facet of implementation, the IPTs were "Mentored" by DSDC associates trained in CMM practices (called process consultants).

The DSDC SEPG then sought and obtained a $1M investment from DLA-AQ to accelerate implementation of CMM Level 2 on DLA-AQ funded software development projects utilizing the Educate, Train, Develop Skills and Mentor approach.

During the implementation process, the SEPG continued to collect lessons learned and recommendations for improvement and incorporated these on a quarterly basis into the DLA standard software development process (process guide). Also during this time, the DSDC SEPG closely monitored the quarterly self-assessment metrics to gauge progress and readiness for a formal assessment by a Software Engineering Institute (SEI) certified lead assessor.

Having determined that the DSDC Procurement product line was ready to be assessed, and feeling confident that the assessment would validate that the processes used by DSDC were at Level 2 of the CMM, the SEPG exercised the DoD contract for formal assessments. Two SEI-certified lead assessors were assigned to DSDC and the assessment was conducted across the DSDC Procurement product line in February 1997.

The assessment showed that the assessed entity was operating at Level 2 of the CMM and the lead assessors "certified" DSDC at that level. The assessment findings also showed that, while DSDC had a few weaknesses and candidates for improvement at Level 2, DSDC had met all 20 of the goals for all 6 of the Key Process Areas (KPAs) at CMM Level 2. The findings also showed that DSDC had many strengths at CMM Level 3. So many, in fact, that 15 of the 17 goals across the 7 Key Process Areas at CMM Level 3 were either fully or partially satisfied (4 fully, 11 partially). The final findings from this assessment are available at the DSDC web site (www.dsdc.dla.mil). This SPI Operational Business Plan identifies and prioritizes improvement activities that address the findings from this formal assessment as well as those areas for improvement identified by DLA and DSDC senior management and our customers.

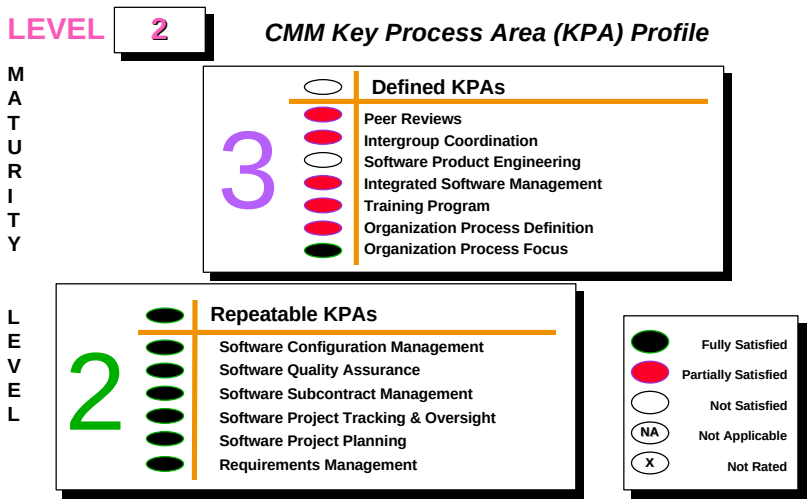


Figure 15. DSDC Formal Assessment Results, Feb 97

At the time of DSDC's formal assessment, industry metrics collected by the SEI from assessments show that 70% of the software engineering industry who have been formally assessed are at the Initial level (Level 1), while only 18% have achieved CMM Level 2. Compare that to the 6% who have achieved CMM Level 3 and the less than 2% that have achieved CMM Levels 4 and 5.

The end result is that DSDC accomplished the detailed planning and coordination, process integration, required definition changes, implementation, education, training, skill development and mentoring that resulted in meeting the corporate goals and objectives outlined in the FY96 SPI Operational Business Plan. This was accomplished on schedule, within budget, with little to no disruption to production work schedules. This is a significant accomplishment for an organizational change effort of this magnitude to have progressed at the rate of this effort (i.e., achieving CMM Level 2 (only 18% of the industry) in 15 months (compared to the industry average of 27 months). In May 1997, Vice President Al Gore recognized DSDC's SPI accomplishments with a "Hammer Award" (his answer to yesterday's government and its $400 hammer) for working to build a better government by reinventing government principles.

7. ORGANIZATION FOR PROCESS IMPROVEMENT

Describes the resource infrastructure necessary to support and implement SPI changes at DSDC in terms of composition, structure, roles and responsibilities throughout the improvement effort, and interfaces and coordinating activities.

7.1 DSDC Executive Steering Group (ESG)

The DSDC Executive Steering Group (ESG) provides policy, oversight, management, guidance and resources for the SPI effort and is ultimately accountable for strategic planning for SPI and ensuring its success. The ESG is composed of Command and each Executive Director within DSDC. Through approval of this SPI plan, the ESG demonstrates to all DSDC associates their commitment to SPI by:

- Funding, staffing, and providing other resources for the SPI effort at DSDC
- Establishing strategies for managing and implementing process development and improvement activities
- Ensuring that DSDC's standard software process supports DoD, DLA and DSDC business goals and strategies
- Coordinating with DLA and DSDC managers to secure the managers' and staff's continuing support and participation in the SPI effort

As the *sponsors* of SPI at DSDC, ESG decisions and actions will be based upon managing the SPI group(s), actively participating in the review of draft SPI processes, approving processes for corporate use at DSDC, proactively instituting approved SPI processes in DSDC, and fulfilling their CMM responsibilities as defined in each CMM Key Process Area (KPA).

7.2 DSDC Software Engineering Process Group (SEPG)

7.2.1 Role

The SEPG is the focal point and catalyst, or *change agent,* for process improvement in the SEI software process improvement model. Composed of practitioners possessing varied skills, such as software requirements analysis, software design, coding, software test, software configuration management and software quality assurance, the SEPG is at the center of an organization-wide collaborative effort of everyone involved with software development. SEI recommends SEPG staffing between 1-3% of the software organization.

7.2.2 Responsibilities/Mission

The SEPG is responsible for facilitating continuous software process improvement by collecting lessons learned; recommending changes to the DSDC standard software process; and proliferating successful processes, tools and methods used by DSDC software projects throughout DSDC. The SEPG is responsible for development or identification and analysis of software processes and practices for recommended use at DSDC (the organization's standard software process).

The SEPG is also responsible for managing SPI progress measurement for DSDC through on-going self assessments, mini assessments, SEI assessments, possible Software Capability Evaluations (SCEs) and participation in the DSDC Metrics Program. The SEPG acts as the principal advisor and technical expert to Command and the Executive Directors on software process activities that improve DSDC's software processes and procedures. They plan and manage activities to assess, develop, maintain, coordinate, implement, and improve standard software processes and related process assets across DSDC. The following functions are performed by the SEPG [DSDCM 5810.1].

- Serves as the technical management experts for DSDC in the application of software process improvement and software change management techniques. Plans, facilitates, executes, and manages the software product and process improvement efforts at DSDC consistent with applicable policies, regulations and standards. Solicits support from senior management for DSDC's standard software process.
- Serves as the DSDC focal point to the Software Engineering Institute (SEI), Headquarters, Defense Logistics Agency (DLA), and the Department of Defense (DoD) on matters pertaining to software process improvement.
- Defines, develops, and maintains DSDC's standard software development processes in collaboration with managers and engineering staff that consists of policies, process definitions, procedures, and tools for software development. Develops, documents and maintains DSDC's software processes and related process assets. Provides a basis for cumulative, long-term benefits to DSDC. Facilitates continuous SPI through collection of lessons learned from the use of processes.
- Manages corporate (DSDC) and external (DLA and DoD) integration of software engineering process improvement operations at DSDC, ensuring integrity and continuity.
- Develops policy and process updates for the incorporation of new approaches and new software technology.
- Develops comprehensive SPI plans and schedules. Manages the SPI budget and project plans. Tracks, monitors, and reports on the status of improvement efforts. Informs all SPI participants of the status of SPI activities at DSDC. Reports SPI progress through the corporate metrics program.
- Manages progress measurement for DSDC through on-going self-assessments, mini-assessments, SEI-assisted (formal) software process assessments, and Software Capability Evaluations (SCEs). Develops action plans for software process assessments. Recommends specific assessments and assessment tools, and conducts training for assessments. Facilitates or conducts self-, mini- and/or formal software process assessments or SCEs within DSDC. Develops assessment reports and metrics.

- Recommends corrective actions to directors and senior management on highly controversial and precedent-setting software process matters either referred to or discovered in periodic or directed software assessments.
- Facilitates identification of areas or processes in need of improvement and process definition. Identifies, develops and analyzes software processes and practices for recommended use at DSDC. Defines, develops, and maintains policies, process definitions, procedures, and tools.
- Coordinates evaluation of internal, DoD, and industry “best practices” for corporate-wide reuse. Monitors and evaluates new, refined or unique processes, tools, or methods in use at DSDC through transferring local methods to the corporation.
- Plans, facilitates and oversees DSDC-wide adoption and institutionalization of DSDC’s standard software development processes. Maintains collaborative working relationships with software engineers that supports obtaining, planning, and installing new practices and technologies.
- Formulates and documents plans and policies to assure the software process expertise of associates is maintained. Educates DLA and DSDC managers and practitioners on their respective roles in philosophies, principles, and concepts of Software Process Improvement (SPI) and the Capability Maturity Model (CMM). Coordinates, develops and conducts software process training across DSDC. Arranges for training or continuing education related to process improvements. Educates and informs DSDC associates regarding software process improvements.
- Works with project and line managers whose projects are affected by changes in software engineering practice, providing a broad perspective of the improvement effort. Solicits recommendations from project managers to improve the DSDC’s standard software processes. Provides process consultation to management during the development of projects. Coordinates software process improvement activities with software development projects.
- Manages, evaluates and reports on pilot tests of new processes, methods or tools to enhance or improve DSDC’s standard software process. Coordinates the development or improvement of DSDC’s standard software process or project’s defined software processes.
- Develops and maintains process-related assets such as DSDC’s standard software process, standards, descriptions of software life cycles, software development plans, measurement plans, process tailoring guidelines and criteria, software process architectures, process templates, process training materials, DSDC’s software process database, and a library of process-related documentation.
- Updates process documentation, databases or libraries or repositories to reflect the most current DSDC software development processes. Collects, maintains and makes available data on the software processes and resulting software work products as they relate to DSDC’s standard software process.
- Maintains DSDC’s software process database which includes or references software process metrics data such as software size, effort and cost estimates and actuals; productivity data; peer review coverage and efficiency; and number and severity of defects found in software code. Establishes, coordinates and maintains DSDC’s corporate process improvement library or repository. Communicates and coordinates use of the software process database or process-related library or repository.
- Participates in the DSDC Metrics Program as it relates to software processes such as actual measurement data and information needed to assess the data.
- Conducts reviews of process-related documentation.

7.2.3 Structure

The structure of DSDC's SEPG reflects senior management's belief that SPI must have high visibility within the organization and that Executive Directorates will have matrixed representation on the SEPG to ensure technical integration of software processes across the corporation.

In this structure, there is an SPI organization that reports directly to DSDC Command. A small number of SEPG representatives are assigned to this organization, including the DSDC SEPG Leader who is responsible for ensuring that SEPG members have the required training and tools available to support their activities (e.g., statistical analysis, desktop publishing, database management, and process modeling, etc.). With the exception of the business, administration, and financial management organizations within DSDC, each Executive Directorate is represented by one or more SEPG members who are matrixed full-time to the SEPG Leader for resourcing SPI/ SEPG project plans and schedules. The business and financial management organizations are represented by the Software Process Improvement Office.

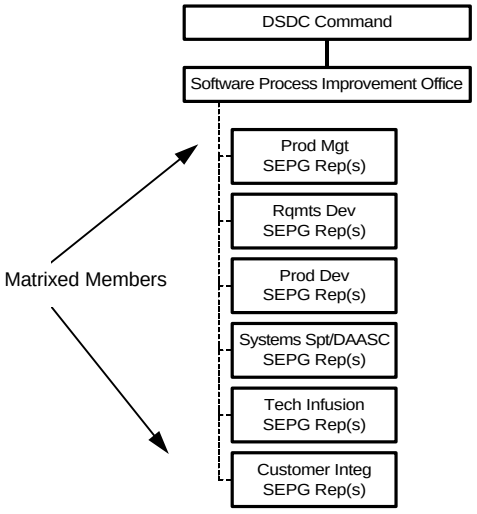


Figure 16. DSDC SEPG Structure

SEPG members may be permanently assigned to the SEPG or may be rotated at the discretion of their respective Executive Director. SEI recommends a tenure of 2-3 years for an SEPG member. The DSDC ESG agreed that rotations, if used, would be for periods of at least one full year. These rotations will be coordinated with the SEPG Leader to ensure that the turnover does not adversely impact the SEPG plan and schedule or the SPI effort and to ensure that all DSDC SEPG members receive the education and training required to perform their SPI/SEPG activities.

SPI coordination and liaison at sites without SEPG representation will be the responsibility of the Site Manager.

7.3 Tactical Working Groups & Implementation Working Groups (TWGs/IWGs)

In most instances, all software process improvement activities will be accomplished utilizing SEPG resources. Tactical Working Groups (TWGs) and/or Implementation Working Groups (IWGs) may be established at the discretion of the ESG in those instances where additional resources may be

required to accelerate process improvement. *Tactical Working Groups (TWGs*), which may periodically supplement SEPG resources, would consist of software practitioners with expertise in the area to be improved. Examples of expertise that may be sought include software reuse, Computer-Aided Software Engineering (CASE) technology, measurement, and training course development. TWGs may be utilized for developing or defining process improvements in an assigned key process area. TWG members serve as *champions* for SPI. *Implementation Working Groups (IWGs)* are made up of all middle managers and software practitioners (and may be assisted by the DSDC SEPG). IWGs may be established to implement processes and procedures approved by the ESG for corporate use at DSDC. IWG members also serve as *champions* for SPI.

The following are examples of SPI-related initiatives that are managed outside of the SEPG (either in mission responsible areas or as TWGs/IWGs) but that are closely interfaced and integrated within the total SPI/SEPG approach. More information on these initiatives can be found in the DSDC Annual Business Plan and/or operational business plans for these specific initiatives.

7.3.1 CASE Implementation

The objective of this effort is the implementation of CASE tools for the development and maintenance of DSDC software products. One key objective in selecting a good CASE tool set is the ability to transfer CASE produced products in and out of a repository in a non-proprietary format. This transfer of product information allows the organization to pass the information from one tool to the next in the product life-cycle. It also allows the organization to purchase new tools without effecting previous and current product development and/or maintenance. The results of establishing a CASE strategy should improve software quality and productivity while reducing cost and risk associated with the development of complex information system applications. The CASE effort is being led by the DSDC Technology Infusion area in conjunction with Requirements Development and Product Development.

7.3.2 PPMT Implementation

The Process and Project Management Tool (PPMT) will aid us in managing our project workload. This tool will be utilized to implement standard business process models reflecting the new methods and procedures for software development and maintenance. A project estimation capability complete with full project planning, tracking and oversight will provide the necessary level of control to ensure project results are predictable. The PPMT effort is being led by the DSDC Product Management area.

7.3.3 Configuration Management

The current challenge is to link the remote development sites so that configuration items are managed centrally, using a *single software suite* across multiple hardware platforms. While managed centrally, these configuration items must be available to remote developers and system users in a timely and accurate manner for viewing and manipulation and status reporting. DSDC's intent is to automate its configuration and release management processes to the maximum extent possible. The CM effort is being led by the DSDC Customer Integration area.

7.3.4 Metrics

DSDC will report via a formal Report Card Performance Measures which record its progress towards the accomplishment of specific management goals. These goals are to 1) Improve Productivity, 2) Improve Quality, 3) Improve Processes, 4) Improve Delivery, 5) Improve Customer Satisfaction, and 6) Improve the Financial Health of the organization. The metrics effort is being led by the DSDC Business Management area.

7.3.5 People Capability Maturity Model (P-CMM)

The P-CMM focuses on continuously developing the human assets of a software or information systems organization. The motivation for the P-CMM is to radically improve the ability of DSDC to attract, develop, motivate, organize, and retain the talent needed to steadily improve software development capability within DLA. P-CMM efforts will be led by the DSDC Business Management area.

7.3.6 Applying the CMM to Technology Services

Recognizing that many of the concepts in the CMM could be beneficial for our (non-software development) technology projects, the DSDC Technology Infusion area is leading an effort to tailor CMM policies, processes, and procedures to that environment.

7.4 SPI Communication

In order to keep all DSDC groups involved in implementing the software processes informed of SPI activities, a Software Process Improvement (SPI) Forum is being developed to help carry out this huge undertaking. Communication of SPI activities is not only the responsibility of the DSDC SEPG, it is the responsibility of all SPI Groups identified in the preceding paragraph. This forum will be chaired by the SPI Program Director and will meet monthly to keep all groups apprised of status, priorities, direction, decisions, action items, and to discuss and resolve open issues pertaining to improvement of DSDC's software development processes.

7.5 DSDC Managers and Supervisors

DSDC managers and supervisors at all levels are responsible for ensuring that higher CMM level processes are institutionalized within their span of control.

7.6 SPI Stakeholders

Stakeholders form a partnership with DSDC. The DLA Chief Information Officer (CIO), DLA-CAN and the business areas of DLA (DLA-AQ, DLA-CA, and DLA-MM) are all stakeholders in SPI. DLA-MM defined it best in their strategic plan, ". . . we perform [our] function through **teamwork and partnerships**. Teamwork throughout our organization, within activities, across activities, and between the headquarters and the field. Partnerships with our suppliers, who are critical contributors in helping us achieve our mission and vision, and with our customers whose support needs drive our mission and vision. We can't take these two words--"teamwork" and "partnerships"--lightly. They describe not only the fact we interact with each other and our suppliers and customers, but also the nature of that interaction. Teams and partners are supportive and contribute to each other's success." [DLA-MM 97].

8. ASSUMPTIONS

Reflects critical assumptions and describes how each of the assumptions affects SPI efforts within DLA.

The success of the DSDC Software Engineering Process Group (SEPG) in carrying out this plan and, ultimately, the success of SPI effort at DLA, is dependent upon the presence of the following six (8.1-8.6) guiding principles for a successful improvement effort [HUMPHREY90]. These principles are basic assumptions that an Agency must make in order to undertake a large change effort. There are no benefits in just *knowing* what to do; rather we must actually *do* it.

8.1 Major changes to the software process must start at the top.

"Senior management leadership is required to launch the change effort and to provide continuing resources and priority."

Proactive senior management support and sponsorship of SPI is needed at *all* levels within DoD.

- **Sponsorship and support of SPI and the CMM have been demonstrated at the DoD level** (as discussed in the *Business Need for SPI* section of this plan).
- **Sponsorship and support of SPI and the CMM have been demonstrated at the DSDC level** (as discussed in the section, *Organization for SPI).*
- **DSDC is proactively soliciting sponsorship and support of SPI by all areas of DLA**. It is an assumption of this plan that all areas within DLA desire to attain the benefits from making major improvements to the software processes used within DLA.

8.2 Ultimately, everyone must be involved.

"Software engineering is a team effort, and anyone who does not participate in improvement will miss the benefits and may even inhibit progress."

Also of critical importance to the success of this plan is the support of the customer community and teamwork among all software development stakeholders: DLA and DSDC associates, managers, and customers and DSDC subcontractors. We must work together to mature our software development processes, demonstrating benefits as we improve our business, securing support, and ultimately partnering with our customer community to obtain their investment in our future. DLA-AQ has recognized the need for this teamwork and has included our process training in their IRM plan curriculum for their senior user representatives across the country [DLA-AQ97]. It is our assumption that, as a member of the DLA team, all areas of the DLA family will work with

DSDC to improve the processes for development and maintenance of DLA software.

8.3 Effective change requires a goal and knowledge of the current process.

"To use a map effectively, you must know where you are and where you are going."

The Capability Maturity Model (CMM) for Software provides DLA with a roadmap for improvement when used with an assessment methodology such as the CMM-Based Appraisal for Internal Process Improvement (CBA-IPI). Once its position in the CMM is defined, an organization can concentrate on those items that will help it advance to the next higher level or it's "destination." It is our assumption that DoD, through its sponsorship of the SEI and its selection of the CMM as a DoD Best Practice," supports use of the CMM for software.

8.4 Change is continuous.

"Software process improvement is not a one-shot effort; it involves continual learning and growth:

- *Reactive changes generally make things worse.*
- *Every defect is an improvement opportunity.*
- *Crisis prevention is more important than crisis recovery."*

"Putting a project on the shelf is an almost certain way to kill it." Once assessed, it is of little or no use if you are not committed to ***unremitting improvement***. No matter how often an assessment is performed, it is only a starting point. It identifies your current level of capability--but more importantly--it identifies a point from which to begin your next round of improvement. Just as HQ DLA embraces Business Process Improvement (BPI) for its other business areas, it is our assumption that, as a member of the DLA family, HQ desires DSDC to continually improve the way we do business.

8.5 Software process changes will not be retained without conscious effort and periodic reinforcement.

"Entropy refers to the steady increase in the randomness or disorder of physical processes. In the absence of conscious effort, human processes behave much the same way."

What gets reinforced sends a message to associates about what is valued in the organization [or Agency]--that is, the behaviors that management really wants and that move the organization [Agency] ahead [MOHRMAN95]. DSDC has made a significant change in the way it does business, a change that was externally and formally assessed against an international industry benchmark. As a result of this change, project costs and schedules have been more reliable

and products delivered are of higher quality. In most government agencies, what is valued is reinforced through the budget process; i.e., what does and does not get funded. How DSDC's accomplishment is reinforced by HQ DLA through the budget process will signal what DLA values. It is an assumption of this plan that DLA values improvement in the development of DLA software.

8.6 Software process improvement requires investment.

"It takes planning, dedicated people, management time, and capital investment:

- *To improve the software process, someone must work on it!*
- *Unplanned process improvement is wishful thinking.*
- *Automation of a poorly defined process will produce poorly defined results.*
- *Improvements should be made in small, tested steps.*
- *Train, train, train!"*

DSDC has proven that it can plan and execute a SPI effort. What is needed is investment. In the past, DLA-CAN has provided funding for some of the SPI efforts at DSDC. Additionally, one of the major sponsors of SPI within DLA has been DLA-AQ who provided FY97 funding for education, training, skill development and mentoring for more than 200 DSDC and 200 DLA-AQ & DCMC associates. DSDC will continue to provide dedicated people and management time to implement higher CMM levels of process maturity. Because we are fee-for-service, it is our assumptions that DLA will provide the investment necessary to achieve the return on investment we have identified in *Business Need for SPI*.

9. RISKS TO SPI AND STRATEGIES TO OVERCOME RISKS

Identifies the risks, including the non-technological risks, to the improvement effort and describes the strategies to reduce those risks.

9.1 The Risk Process

DSDC utilizes the taxonomy-based risk process developed by the SEI. This process, shown in the SEI risk model is used in conjunction with an SEI-developed risk identification method which uses a questionnaire to help projects identify risks [CARR93]. This process is cyclic and as such, repeats for long projects, or multi-phase projects. The process starts with identify, analyze and plan and continues as the manager plans, manages, tracks and controls risks throughout the project. Communication is at the heart of risk management with the SPI Program Director communicating SPI-related risks to HQ DLA, DSDC Command and the SEPG.

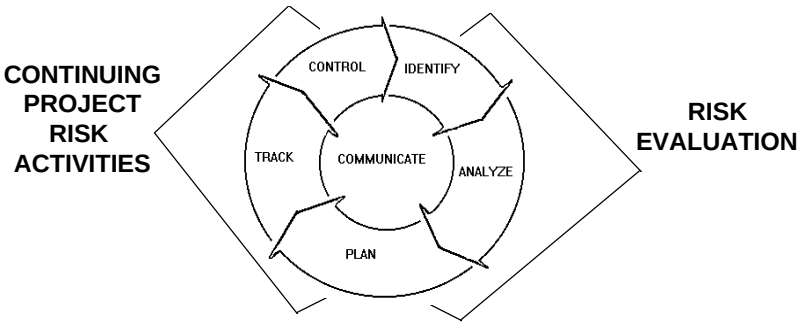


Figure 17. Risk Model

Risks to the SPI effort (as a whole) were identified, analyzed and a risk management plan was developed [SPI RISK97]. At the start of each incremental phase of improvements, the SEPG will begin the risk process again for that particular increment.

9.2 Risks To SPI

In the risk planning process, DSDC identified 34 risks to the SPI effort. Of those only 11 had a probability or impact severe enough to warrant mitigation. DSDC grouped these risks into four categories: Human, Business, Technical, and Political. The most serious risks to SPI (in terms of impact and probability) are *political* risks. They are:

- DLA changes in key management positions
- DLA willingness to fund SPI at DSDC
- Readiness of all parts of DLA to make this change (to CMM Level 3)

Ordinarily these risks might be considered *business* risks; however, DSDC has provided a strong business case complete with ROI data comparable to that of industry to justify the SPI effort. Therefore, these risks are considered *political* in nature since they address sponsorship issues. In order to institutionalize this change, DLA senior management must recognize the value of SPI and sponsor it by providing resources and official backing. A basic quality tenet for a major change was best captured by *the*

pioneer of U.S. quality management, Dr. W.E. Deming, who warned managers that, grass roots efforts, while admirable, will fail without management support.

10. MANAGEMENT APPROACH:

Outlines how DSDC will manage organizational changes that occur as a result of process improvement. Highlights our approach for reporting, communication, and rewards and recognition.

10.1 The IDEAL Model

DSDC will utilize the IDEAL Model to set the stage for its overall software process improvement efforts. This model, developed by the SEI can be used with any improvement or change effort. It describes the phases an improvement effort must plan for: Initiating, Diagnosing, Establishing, Acting, and Learning (the first letter of each forms the acronym IDEAL). The description of this model also defines the benefits of going through each phase, the inherent risks associated with skipping a phase, what types of skills and knowledge are needed for each phase, and which SPI groups must participate in each phase. During the FY96-FY97 time frame, DSDC moved through this model several times (getting support from management, determining where we were, planning for where we wanted to go, defining processes, piloting solutions, and incorporating our lessons learned). This plan is written as part of the Establishing phase of the model.

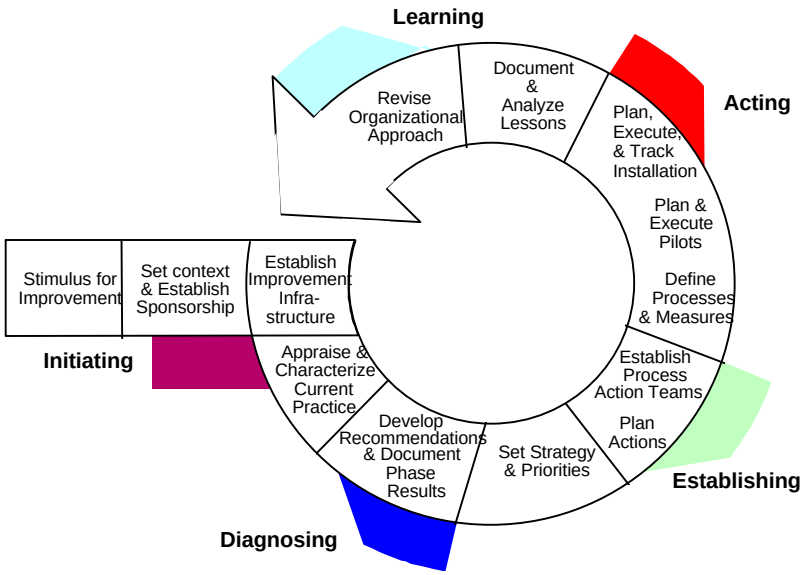


Figure 18. IDEAL Model

10.2 Planning and Management of SPI Efforts

In addition to the Capability Maturity Model and the IDEAL Model, the DSDC SEPG will also tailor the most current policies, standards, processes, procedures, and tools that govern our software development (i.e., planning, tracking, etc.) to the requirements of our SPI efforts. Using the guiding principles of the CMM for SPI efforts will help us to serve as a prototype for modeling higher levels of maturity for the rest of the organization.

This SPI plan serves as the “action plan” as defined in the CMM Key Process Area (KPA) of Organization Process Focus. It is the organizational standard for all SPI efforts. It will be implemented incrementally through development and execution of short term (6-8 month) DSDC SEPG Plans (referred to as “software process development and improvement” plans in the CMM).

These DSDC SEPG Plans will define the activities and schedules for assessing, developing (defining), maintaining, coordinating, and improving the organization’s and projects’ software processes. The following examples provide insight into the types of work associated with these activities.

- Assessment Activities: Training for assessments; assessment tool selection; conducting assessments; developing “follow-up” reports or briefings.
- Development Activities: Definition and documentation of policies, processes, or procedures; development of templates, tailoring guidance, software process architectures or other process-related documentation. Development of process and process-related libraries and repositories.
- Maintenance Activities: Monitoring and evaluating new, refined or different processes, tools, or methods in use at DSDC; transferring “local” methods, tools, or processes to the DSDC corporation; updating process documentation, databases or libraries (repositories) to reflect the most current guidance.
- Coordination Activities: Communicating and coordinating use of the software process database or process-related library (repository); soliciting buy-in for DSDC’s standard software process; conducting reviews of process-related documentation; coordinating the development or improvement of DSDC’s standard software process or projects’ defined software processes; coordinating, developing and/or conducting software process training across DLA, DSDC or projects.
- Improvement Activities: The most critical of all activities. Soliciting recommendations from projects for improving the organization’s standard software process; managing, evaluating and reporting on pilot tests of new processes, methods or tools to enhance or improve DSDC’s standard software process.

The DSDC SEPG Plans will also specify the groups and individuals responsible for each activity and the resources required (including staff and tools). The DSDC SEPG Plans may also have a narrative section which outlines any deviations from (i.e., “tailoring of”) this SPI Plan. Progress against these incremental plans will be reviewed and monitored in accordance with the standards, guidelines, and policies set forth for all DSDC projects.

10.3 SPI Through Recognition

The ability to change behavior in an organization is directly tied to the amount of preparation leaders use to move their people up the learning curve. But learning only equips individuals with the tools to do the job correctly and proficiently. It does not ensure behavior will change. For change to happen, leaders must ensure people in the organization know what behavior is expected, which is done through cascading sponsorship and through alignment of the rewards and recognition system [DUFAUD96].

In order to positively reinforce the change that is desired, implementation of continually improving processes, DSDC must publicize goals for SPI as defined in the *Criteria for Success* section of this plan. The concepts that follow are some methods for rewarding or recognizing DSDC individuals or groups who support the SPI effort or who achieve SPI progress.

10.3.1 Possible Circumstances for Recognition

- Highest percent of CMM compliance (improvement or progression)
- Percent of progress by projects/product lines/geographic location toward a SPI goal
- Significant effort
- 100% achievement of a CMM Level
- 80+% achievement of a specific KPA
- Significant contribution or achievement as defined and agreed to by the DSDC ESG and SEPG
- Assistance for populating the process repository
- Outstanding or significant sponsorship or championship of SPI (managers, practitioners, customers)

10.3.2 Possible Types of Recognition

- Name announced in staff meeting by DSDC SPI Program Director or Executive Director
- Letter of Appreciation
- Trophy Case Award
- Attendance at a selected training conference
- Special software or supplies
- On-the-Spot Award
- Thank You Letters, Letters of Appreciation
- Certificates
- Associate to Associate/Peer Recognition: "Thanks! You Made A Difference!"
- Supervisor Recognition: "Good Work! You Made My Job Easier!".
- Customer Service Award
- Quality Leadership Award

11. ASSESSMENT APPROACH:

Outlines the strategy for reusing process assets developed both internally and externally, and denotes the standards which govern the manner in which the SPI effort will be carried out.

11.1 Assessment Methods

Process assessment will help DSDC improve itself by evaluating which CMM processes have been defined *and* implemented, identifying our critical problems and establishing our improvement priorities. The SEI assessment methodology looks at what is defined and documented, what is understood and what is being used within an organization. Assessments typically look at all software processes used in DSDC; however, DSDC will use three types of assessments to gauge our maturity against the CMM.

11.1.1 Self Assessment

The first type of assessment will be a self-assessment. After receiving the necessary training, designated DSDC associates will assess projects and processes across DSDC. Using an automated collection and evaluation tool based on the CMM, associates will complete an electronic survey which contains a series of questions regarding his/her project or assigned Key Process Areas (KPAs). Self-assessments will be conducted quarterly. Results will be depicted by product line and by DSDC as a whole and will be used by the SEPG as input to the improvement planning process.

11.1.2 Internal Assessments

This type of assessment will be used on a sampling of projects to verify and evaluate the results of the self-assessments. Conducted by trained DSDC assessment teams selected and sponsored by the DSDC SEPG, internal assessments involve evaluating the results of the self-assessments, scripting additional questions, and conducting interactive interviews with DSDC managers and associates. Results of internal assessments will be used by the SEPG as input to the improvement planning process.

11.1.3 Formal Assessments

Because formal assessments are extremely time-consuming and costly, the DSDC SEPG will recommend formal assessment when it can be reasonably assured that a DSDC has achieved the next CMM level; that is, when self- and internal assessment results indicate that a DSDC product line is in compliance with the CMM requirements of each KPA for the next CMM level.

DSDC has selected the CMM-Based Appraisal for Internal Process Improvement (CBA-IPI) method of formal assessment. CBA-IPIs are an effective method for determining the maturity of our processes by identifying our strengths, weaknesses and areas for improvement. CBA-IPIs provide an industry-wide performance rating and benchmarking system that was established to be fair, accurate, and enforce uniform procedures, clear definitions, consistent measurements, and reliable information. CBA-IPIs are conducted by independent SEI-certified providers in conjunction with a team of trained DSDC associates. Results of CBA-IPIs will be used by the SEPG as input to the improvement planning process.

Formal assessments (CBA-IPIs) will be conducted every 1-1/2 to 3 years on each DSDC product line. Budget negotiations during the FY98 Program Objective Memorandum (POM) process resulted in the HQ DLA CIO making a decision to postpone all formal assessments of DSDC until FY99; therefore, the next formal assessment of DSDC is planned for the 2nd Quarter FY99 time frame.

12. CRITERIA FOR SUCCESS

Describes how goals will be measured and how DSDC will recognize success in achieving those goals. It also describes how improvement activities will be measured and evaluated at both the organizational and project levels.

12.1 DSDC SPI Progress

Measurements will be made and used to determine the status of DSDC's progress relative to the goals and objectives contained in the DSDC Business Plan. Increased productivity through reduction of rework, improved schedule performance, improved cost performance, and reduced defect metrics (as discussed in the *Business Need For SPI* section of this plan) will help DSDC recognize success in achieving its goal of climbing the CMM ladder and will be used for planning follow-on SPI activities.

12.1.1 Goal

TO INCREASE DSDC'S CONTRIBUTION TO DLA'S MISSION BY MATURING DSDC'S SOFTWARE ENGINEERING AND SYSTEM INTEGRATION CAPABILITY

DSDC enhances DLA's ability to meet its mission through development and maintenance of DLA's software-intensive systems. It is DSDC's responsibility to continuously mature system development capability. The heart of our SPI efforts is based on the CMM. DSDC's current efforts are aimed at attaining a full CMM Level 3 capability which requires us to incorporate multiple disciplines: Systems Engineering, Acquisition, Personnel Management as well as Software Engineering. The success of this goal is being measured by the amount of improvement to our system/software engineering capabilities.

12.1.2 Objectives

12.1.2.1 Implementation/Improvement of DSDC's Standard System Development Process

At CMM Level 2, each project defines the management/development process it will follow. The basis of CMM Level 3 is an organizational standard process which each project tailors into its own project-specific approach as dictated by project need. DSDC is baselining that process now. As more and more DSDC projects implement the standard process and pass along lessons learned, the process is updated/improved, continuously making it more fit for use across all of DSDC.

12.1.2.2 Selection and Use of Improved Methods and Tools to Support the Standard Process

An important part of defining an effective process is the identification of the methods and tools that most effectively implement the process. By standardizing our processes at the organizational level, DSDC can achieve economies of scale when acquiring tools that a project-by-project approach cannot produce.

12.1.2.3 Identification of Education and Training

The Systems and Software Engineering disciplines are rapidly evolving, requiring diligence to keep skills current. Investment in process definition provides little return until real people use the process on real projects. DSDC's standard process facilitates the identification of system development skills and the education and training required to gain and maintain those skills thus promoting more efficient use of training dollars.

12.1.3 Measurements

Metrics for usage of the standard process and capability assessments (see paragraphs 12.1.3.1 and 12.1.3.2 in this section) are currently being collected at DSDC and were defined, baselined and implemented with CMM Level 2. These two metrics proved to be very valuable to our improvement activities. As we move toward CMM Level 3 during FY98, DSDC will formalize definition and baseline activities for the process training and method/tool effectiveness metrics (see paragraphs 12.1.3.3 and 12.1.3.4 in this section). The process training metric is currently collected in one DSDC directorate. The fourth metric (method/tool effectiveness) will be defined and baselined in FY98.

12.1.3.1 Determine Usage of DSDC's Standard Process

Process usage is being measured through quarterly process assessments self-administered by each DSDC project. These metrics are reported both by product line and DSDC-wide. The results of the self-assessments are validated through Software Quality Assurance corporate objective reviews of process compliance by projects within DSDC's product lines.

12.1.3.2 Perform Capability Assessments Across DSDC

DSDC's capability to develop software-intensive systems is determined through formal assessments measured against the CMM for Software. These assessments are led by certified CMM assessors who are external to DSDC. DSDC has undergone an initial assessment of one product line. Future assessments will be also be administered at the product line level and will be tailored as appropriate to include assessment of activities in other CMMs (e.g.,

System Engineering, Acquisition and People). This measurement reports not only the CMM level attained but also process weaknesses and areas for improvement on which future improvement activities will be based.

12.1.3.3 Determine Process Training Effectiveness

This measurement will track the amount of education and training by process role based upon the process training identified in organizational training plans (a CMM Level 3 activity under the Training Program KPA).

12.1.3.4 Determine Method/Tool Effectiveness

This measure will be track the usage of individual development methods and tools. It will track not only what tools are being used but also project team recommendations for specific tool use on future projects.

13. PRIORITIES AND SCHEDULES

Lays out the tenets to be used for developing schedules for improvement. Includes Gantt charts depicting which assessment findings will be addressed and the sequencing and elapsed time for performing SPI work prioritized by the DSDC Executive Steering Group (ESG).

This plan is being implemented according to the priorities and guidance of the ESG based upon their knowledge of DSDC and other improvement initiatives, assessment findings, and/or coordination, requirements or issues from DLA and DSDC's customers. This plan depicts the most current guidance for implementing SPI. As assessments are conducted and new requirements or guidance are received, the impact will be assessed and new plans developed and negotiated.

ID	Task Name	Start	Finish
1	**INCR 1 (Oct97-Mar98)**	**10/01/97**	**03/31/98**
2	**Improve-ALL CMM L2+ Procedures**	10/01/97	03/31/98
3	**Definition-All CMM L3 Procedures**	10/01/97	03/31/98
4	**Improve Process Models**	10/01/97	03/31/98
5	**Provide CMM L2+ Stakeholder Education**	10/01/97	03/31/98
6	**Develop CMM L3 Stakeholder Education**	10/01/97	03/31/98
7	**Conduct L2+ Stakeholder Trng/Workshops**	10/01/97	03/31/98
8	**Create SPI Repository**	10/01/97	03/31/98
9	**Define Corporate Metrics**	10/01/97	03/31/98
10	**Define DAASC CMM Processes**	10/01/97	03/31/98
11	**INCR 2 (Apr98-Sep98)**	**04/01/98**	**09/30/98**
12	**Improve-ALL CMM L2&3 Procedures**	04/01/98	09/30/98
13	**Definition-Integ of CMMs**	04/01/98	09/30/98
14	**Improve Process Models**	04/01/98	09/30/98
15	**Conduct CMM L2&3 Stakeholder Education**	04/01/98	09/30/98
16	**Conduct L2&3 Stakeholder Trng/Workshops**	04/01/98	09/30/98
17	**Conduct Internal Assessments**	04/01/98	09/30/98
18	**Maintain SPI Repository**	04/01/98	09/30/98
19	**Improve Corporate Metrics**	04/01/98	09/30/98
20	**Implement DAASC CMM Processes**	04/01/98	09/30/98

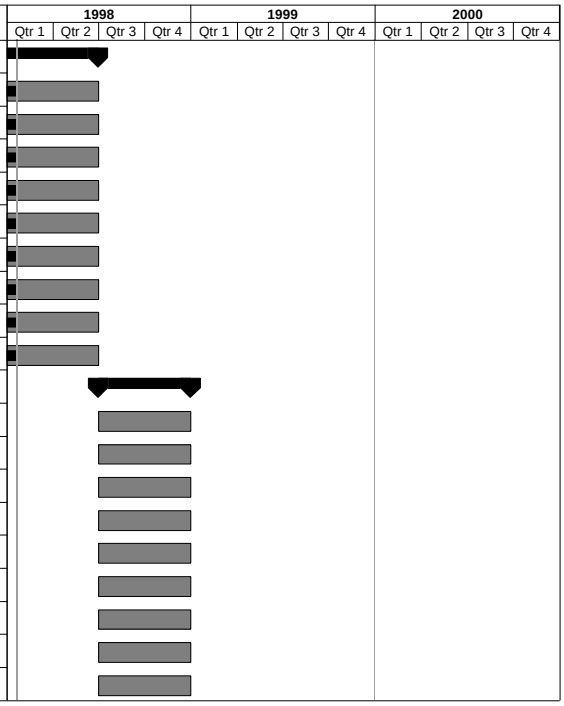


Figure 19. FY98 SPI Schedule

ID	Task Name	Start	Finish
21	**INCR 3 (Oct98-Mar99)**	**10/01/98**	**03/31/99**
22	**Improve-ALL CMM L2&3 Procedures**	10/01/98	03/31/99
23	**Implement Integ of CMMs**	10/01/98	03/31/99
24	**Improve Process Models**	10/01/98	03/31/99
25	**Provide CMM L2&3 Stakeholder Education**	10/01/98	03/31/99
26	**Conduct L2&3 Stakeholder Trng/Workshops**	10/01/98	03/31/99
27	**Conduct Internal Assessments**	10/01/98	03/31/99
28	**Conduct Formal Assessment**	10/01/98	03/31/99
29	**Maintain SPI Repository**	10/01/98	03/31/99
30	**Improve Corporate Metrics**	10/01/98	03/31/99
31	**Improve DAASC CMM Processes**	10/01/98	03/31/99
32	**INCR 4 (Apr99-Sep99)**	**04/01/99**	**09/30/99**
33	**Improve-ALL CMM L2&3 Procedures**	04/01/99	09/30/99
34	**Implement Integ of CMMs**	04/01/99	09/30/99
35	**Improve Process Models**	04/01/99	09/30/99
36	**Provide CMM L2&3 Stakeholder Education**	04/01/99	09/30/99
37	**Conduct L2&3 Stakeholder Trng/Workshops**	04/01/99	09/30/99
38	**Conduct Internal Assessments**	04/01/99	09/30/99
39	**Conduct Formal Assessment**	04/01/99	09/29/99
40	**Maintain SPI Repository**	04/01/99	09/30/99
41	**Improve Corporate Metrics**	04/01/99	09/30/99
42	**Implement Technology SPI**	04/01/99	09/30/99
43	**Assess DAASC CMM Processes**	04/01/99	09/30/99

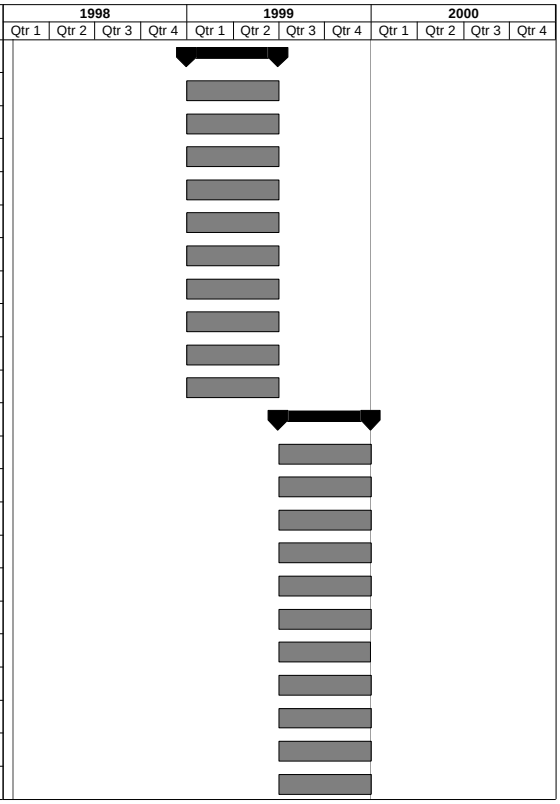


Figure 20. FY99 SPI Schedule

14. RESOURCE REQUIREMENTS

Includes funding strategies for SPI together with a breakout of personnel, facilities, and budget needed to implement the priority actions of the ESG and to execute the SPI effort at DSDC. This section also contains requirements for tools and training necessary for software process improvement activities.

14.1 Personnel

ORGANIZATION	TOTAL NO. OF SEPG PERSONNEL	LEVEL OF EFFORT
Software Process Improvement (SPI) Office (DSDC-DS)	4	4 FT @100%
Product Management (DSDC-M)	2	1 FT @100% 1 PT @ 60%
Requirements Development (DSDC-R)	1	1 FT @100%
Product Development (DSDC-P)	2	2 FT @100%
Technology Infusion (DSDC-T)	1	1 FT @100%
Customer Integration/CM (DSDC-C)	1	1 FT @100%
Systems Support (DSDC-S/DAASC)	1	N/A*
TOTAL	**12**	**10.6 FTEs**

*Systems Support/DAASC SEPG representation is funded by the Military Services

Table 11. DSDC SEPG Resource Requirements

14.2 SPI Funding Profile

14.2.1 FY98

In FY98, the SPI effort and the SEPG will be considered “indirect.” The DLA CIO provided direction to DSDC to include any costs associated with SPI as “unfunded,“ meaning that DSDC would suffer a negative Net Operating Result (NOR) in FY98. Although the Software Process Improvement Office estimated FY98 expenditures at $2.9 million, the SPI negative NOR for FY98 was capped by the DLA CIO at $1.4 million during negotiation conducted during the FY98 POM cycle. The original $2.9 million estimate was based on DSDC providing CMM and SPI education and training to DSDC associates as well as to DLA customer and user representatives during the FY98 timeframe. This estimate was well within the SEI annual budget guidelines of 1-3% for SPI. The original submission also included funding for formal assessments which the DLA CIO eliminated during FY98, postponing all formal assessments of DSDC until the FY99 time frame. Of the re-negotiated $1.4 million of funding for FY98 (which is

at the extreme low end of the SEI guidelines), the following specific costs were negotiated. They include the SEPG labor and non-labor dollars:

a. Labor		
	Technical Support to HQ	$ 11,448.00
	CMM Process Modeling Support	360,612.00
	CMM Process Implementation Support	509,252.00
	Asset Repository Support	240,408.00
b. Non Labor		
	Travel	147,700.00
	Contractor Training	130,000.00
	TOTAL	$1,399,420.00

Special projects (similar to the one conducted for DLA-AQ in FY97) may be funded separately by our customers.

14.2.2 FY99

In FY99, the cost of SPI within DLA will be included in the DSDC unit cost rate.

14.3 Training

14.3.1 DSDC Training

Beginning in FY98, DSDC directorates will be required to develop and revise organizational training plans in accordance with the requirements of CMM Level 3. These training plans will identify the specific needs by directorate and estimate cost and schedules for the training requirements. The DSDC SEPG recommends that each directorate identify 24-32 hours per year per associate for SPI-related training (in the directorate training plans).

14.3.2 DSDC SEPG Training

Just as programmers and other practitioners at DSDC require training to update their skills, the SEPG also needs to keep its skills current. Although the SEPG is a matrixed group, the Software Process Improvement office is responsible for developing an annual training plan to identify and secure SEPG and SPI-related training for all DSDC SEPG members.

15. APPROVALS

//SIGNED//	1-7-98
PATTI J. HICKS SPI Program Director DLA Systems Design Center	DATE:
//SIGNED//	1-7-98
P. K. ANDERSON CAPT, SC, USN Commander	DATE:

16. INDEX

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APPENDICES

Appendix A, References

[BATE95] Bate, Roger, et al., "*A Systems Engineering Capability Maturity Model (SE-CMM)*," Version 1.1, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, November 1995.

[BOEHM81] Boehm, Barry W., Software Engineering Economics, Prentice Hall, Englewood Cliffs, New Jersey, 1981.

[CARR93] Carr, Marvin J. et al, "*Taxonomy-Based Risk Identification*," Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, June 1993.

[CIO96-12] DLA-CAN CIO Letter 96-12, "*Software Process Improvement*," August 30, 1996.

[COSTELLO88] Costello, Robert B., *in a presentation to the Air Force Scientific Advisory Board*, The National Defense University, October 20, 1988.

[CURTIS93] Curtis, Bill, et al., "Capability Maturity Model for Software," Version 1.1, and "Key Practices of the Capability Maturity Model," Version 1.1, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, February 1993.

[DAVIS93] Davis, A., Software Requirements: Objects, Functions and States, Prentice Hall, Englewood Cliffs, New Jersey, 1993.

[DBOF93] Comptroller of the DoD, Directorate for Business Management, "*DBOF Reports to Congress on Milestones I and II Implementation*," February 1993.

[DELAVIGNE94] Delavigne, Kenneth T., Robertson, J. Daniel, Deming's Profound Changes: When Will the Sleeping Giant Awaken?, Prentice Hall PTR, Upper Saddle River, New Jersey, 1994.

[DION93] Dion, Ray, "*Process Improvement and the Corporate Balance Sheet*," IEEE Software, Vol 10, pp. 28-35, July 1993.

[DLA-AQ97] "*Defense Contract Management Command (DCMC) Information Resource Management (IRM) Plan*", June 1997.

[DLA-MM97] "*DLA-MM Strategic Plan*," September 1997.

[DLAR 5010.4] DLAR 5010.4, "*Internal Management Control Program*," October 12, 1990.

[DSDCM 5810.1] DSDCM 5810.1, "*DSDC Mission and Functions Manual*," March 31, 1997.

[DoD 5000.1] DoD 5000.1, "*Defense Acquisition*," March 15, 1996.

[DUFAUD96] Dufaud, Scott B. and Carter, Lynn R., "*Software Is The Mission*," in a presentation to the Eighth Annual Software Technology Conference, April 1996.

[FM770-778] USALMC Army Field Manual, "*Systems Engineering*," Training Support Center, Ft. Eustis, Virginia.

[FOWLER90] Fowler, Priscilla and Stan Rifkin, "*Software Engineering Process Group Guide*," Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, September 1990.

[FOWLER97] Fowler, Kinsey M., "*SEI CMM Level 5: A Practitioner's Perspective*," CrossTalk, Vol 10, No 9, September, 1997.

[GAO96] U.S. General Accounting Office, *"Software Capability Evaluation: VA's Software Development Process is Immature,"* June 1996.

[GAO97] U.S. General Accounting Office, Accounting and Information Management Division, "*Assessing Risks and Returns: A Guide for Evaluating Federal Agencies' IT Investment Decision-making*," Version 1, February 1997.

[GLASS92] Glass, Robert L., Building Quality Software, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1992.

[HEFLEY95] Hefley, William E., et al., "*People Capability Maturity Model (P-CMM), Incorporating Human Resources into Process Improvement Programs*," Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, 1995.

[HUMPHREY90] Humphrey, Watts S., Managing the Software Process, Software Engineering Institute, Addison-Wesley Publishing Company, Reading, Massachusetts, 1990.

[IRM97] "*DLA Information Resources Management (IRM) Strategic Plan*," March 11, 1997.

[JACOBSEN89] Jacobsen, John M., "*Value-based Contracting*, *In Proceedings, SOFTCON '89: Managing Software into the 90's . . . Acquiring the Competitive Edge*," pp. 189-203, American Defense Preparedness Association, 1989.

[JONES94] Jones, Capers, Assessment and Control of Software Risks, Yourdon Press, Englewood Cliffs, New Jersey, 1994.

[MIL-STD-498] MIL-STD-498, "*Software Development and Documentation*," December 5, 1994.

[MOHRMAN95] Mohrman, Susan Albers, Cohen, Susan G., and Mohrman, Allan M. Jr., Designing Team-Based Organizations: New Forms for Knowledge Work, Jossey-Bass, Inc., San Francisco, California, 1995.

[MOSEMANN96] Mosemann, Lloyd K., II., Guidelines for Successful Acquisition and Management of Software-Intensive Systems: Weapons Systems, Command and Control Systems, Management Information Systems, Volume 1, Department of the Air Force Software Technology Support Center, Ogden, Utah, 1996.

[OLSON94] Olson, Timothy G., Neal R. Reizer, James W. Over, "*A Software Process Framework for the SEI Capability Maturity Model*," Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, September 1994.

[OSD C^3I 97] DoD "*Information Technology Management (ITM): Supporting National Defense*," ITM Strategic Plan, Version 1.0, March 1997.

[PAULK93] Paulk, Mark C., *"Comparing ISO 9001 and the Capability Maturity Model for Software*," Software Quality Journal, Vol. 2, No. 4, pp. 245-256, December 1993.

[PAULK94] Paulk, Mark C., "*A Comparison of ISO 9001 and the Capability Maturity Model for Software*," Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, August 1994.

[PUTNAM93] Putnam, Lawrence H., Arlyn D. Schumaker and Paul E. Hughes, "*Economic Analysis of Re-Use and Software Engineering Process,"* (Final Draft Report) prepared for Standard Systems Center, Air Force Communication Command, Maxwell Air Force Base, Alabama 36114, under Contract F01620-90-D-007, February 1993.

[QUANN93] Quann, Eileen, "*Software Will Change the Way We Live*," Fastrak Training, Inc., Columbia, Maryland, September 1993.

[SHELDON92] Sheldon, F., K. Kavi, and R. Tausworthe, "*Reliability Measurement From Theory to Practice*," IEEE Software, Vol 9, pp.13-20, July 1992.

[SPI RISK97] *"DSDC SPI Level 3 Risk Plan*," July 18, 1997.

[STANDISH94] The Standish Group, "*The CHAOS Report*," Dennis, Massachusetts, 1994.

[TAVOLATO84] Tavolato, P. and K. Vencena, "*A Prototyping Methodology and Its Tool*," In R. Buddle, et al (eds.), Approaches to Prototyping, Berlin-Springer-Verlag, 1984.

Appendix B, Acronym Listing

ABC:	Activity Based Costing
BPI:	Business Process Improvement
BRAC:	Base Realignment and Closure
CASE:	Computer Aided Software Engineering
CBA-IPI:	CMM Based Appraisal for Internal Process Improvement
CDA:	Central Design Activity
CIO:	Chief Information Officer
CM:	Configuration Management
CMM:	Capability Maturity Model (for Software)
CMU/SEI:	Carnegie Mellon University, Software Engineering Institute
CSC:	Computer Sciences Corporation
CSCI:	Computer Software Configuration Item
DBOF:	Defense Business Operating Fund *(see DWCF)*
DCMC:	Defense Contract Management Command
DLA:	Defense Logistics Agency
DoD:	Department of Defense
DSDC:	DLA Systems Design Center
DWCF:	Defense Working Capital Fund
EC/EDI:	Electronic Commerce/Electronic Data Interchange
ESG:	Executive Steering Group
FT:	Full Time
FTE:	Full Time Equivalent
GAO:	General Accounting Office
GPRA:	Government Performance Results Act
HQ:	Headquarters
HWCI:	Hardware Configuration Item
ICASE:	Integrated Computer Aided Software Engineering
IDEAL:	Initiating, Diagnosing, Establishing, Acting, Learning
IEEE:	The Institute of Electrical and Electronics Engineers
IG:	Inspector General
IMC:	Internal Management Control
IPD-CMM:	Integrated Product Development CMM
IPPD:	Integrated Process and Product Development
IPT:	Integrated Product Team

IRM: Information Resources Management

ISO: International Standards Organization

IT: Information Technology

ITM: Information Technology Management

ITMRA: Information Technology Management Reform Act

IWG: Implementation Working Group

IUS: Inertial Upper Stage

JAD: Joint Application Development

KPA: Key Process Area

LOC: Lines Of Code

MTTD: Mean Time to Defect

N/A: Not Applicable

NOR: Net Operating Result

OSD API: Office of Under Secretary of Defense for Acquisition Program Integration

OSD C^3I: Office of Under Secretary of Defense for Command, Control, Communications, and Intelligence

P-CMM: People Capability Maturity Model

PO: Program Officer

POM: Program Objective Memorandum

PPMT: Process and Project Management Tool

PT: Part Time

ROI: Return On Investment

SA-CMM: Software Acquisition CMM

SAIC: Science Applications International Corporation

SCE: Software Capability Evaluation

SE-CMM: Systems Engineering CMM

SEI: Software Engineering Institute

SEPG: Software Engineering Process Group

SPI: Software Process Improvement

SSC: Standard System Center

TQM: Total Quality Management

TWG: Tactical Working Group

USAF: United States Air Force

USN: United States Navy

WWW: World Wide Web

Appendix C, List of Figures and Tables